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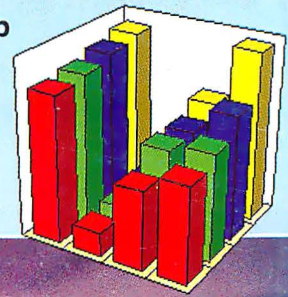
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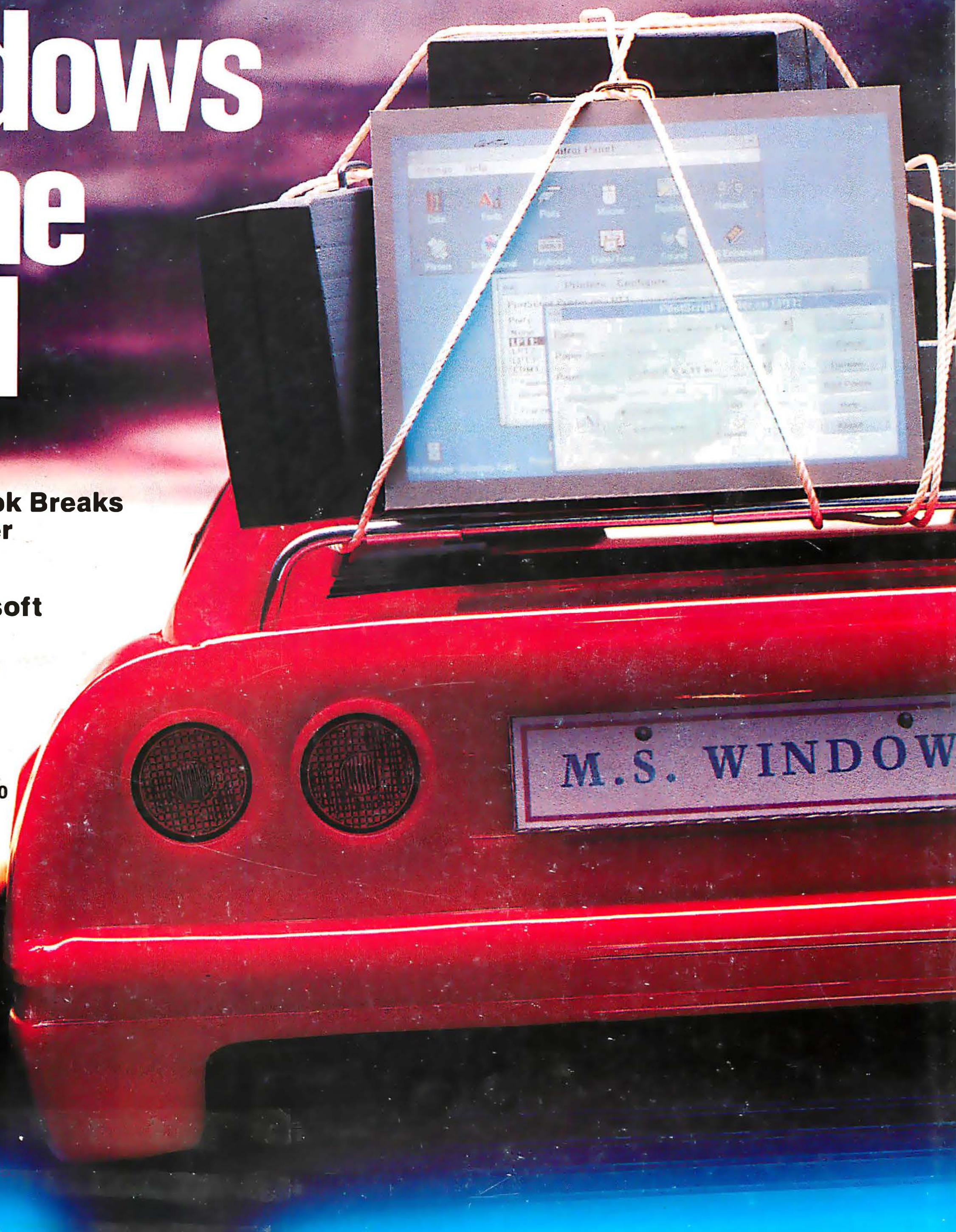
BYTE Lab Product Report

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Top Portables and Pointing Devices for

Windows on the Road



Dell Color Notebook Breaks $4000 Price Barrier

C++ Wars: Borland vs. Microsoft

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Breakthroughs in Memory and Storage Page 160

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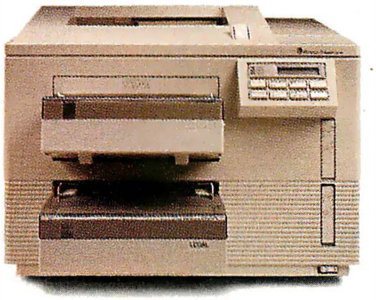
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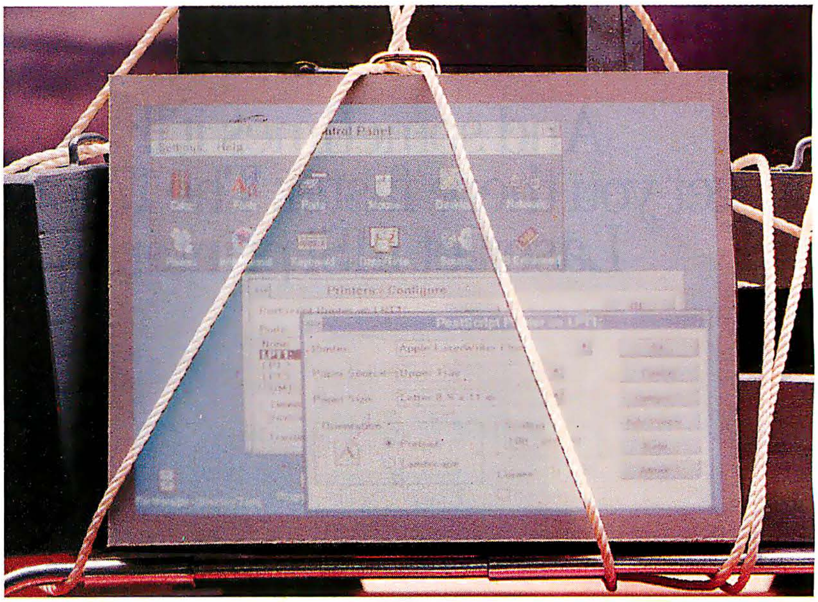
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March 1992 *Volume 17, Number 3*

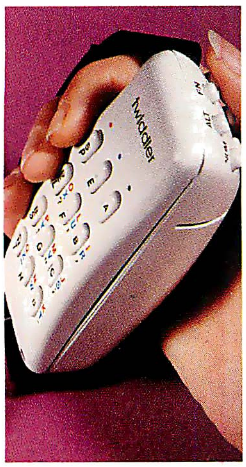
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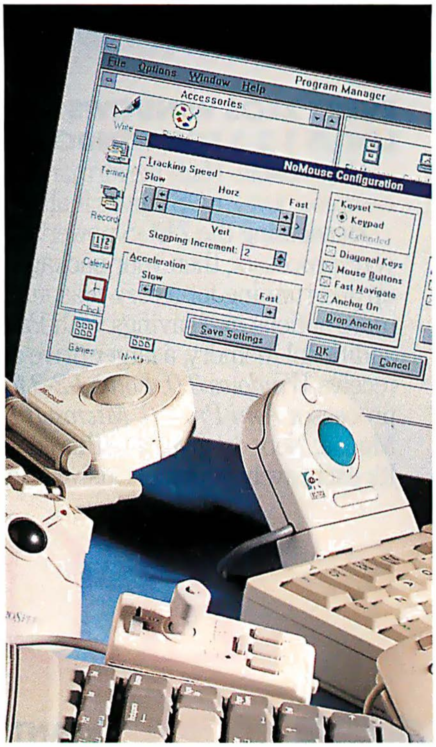


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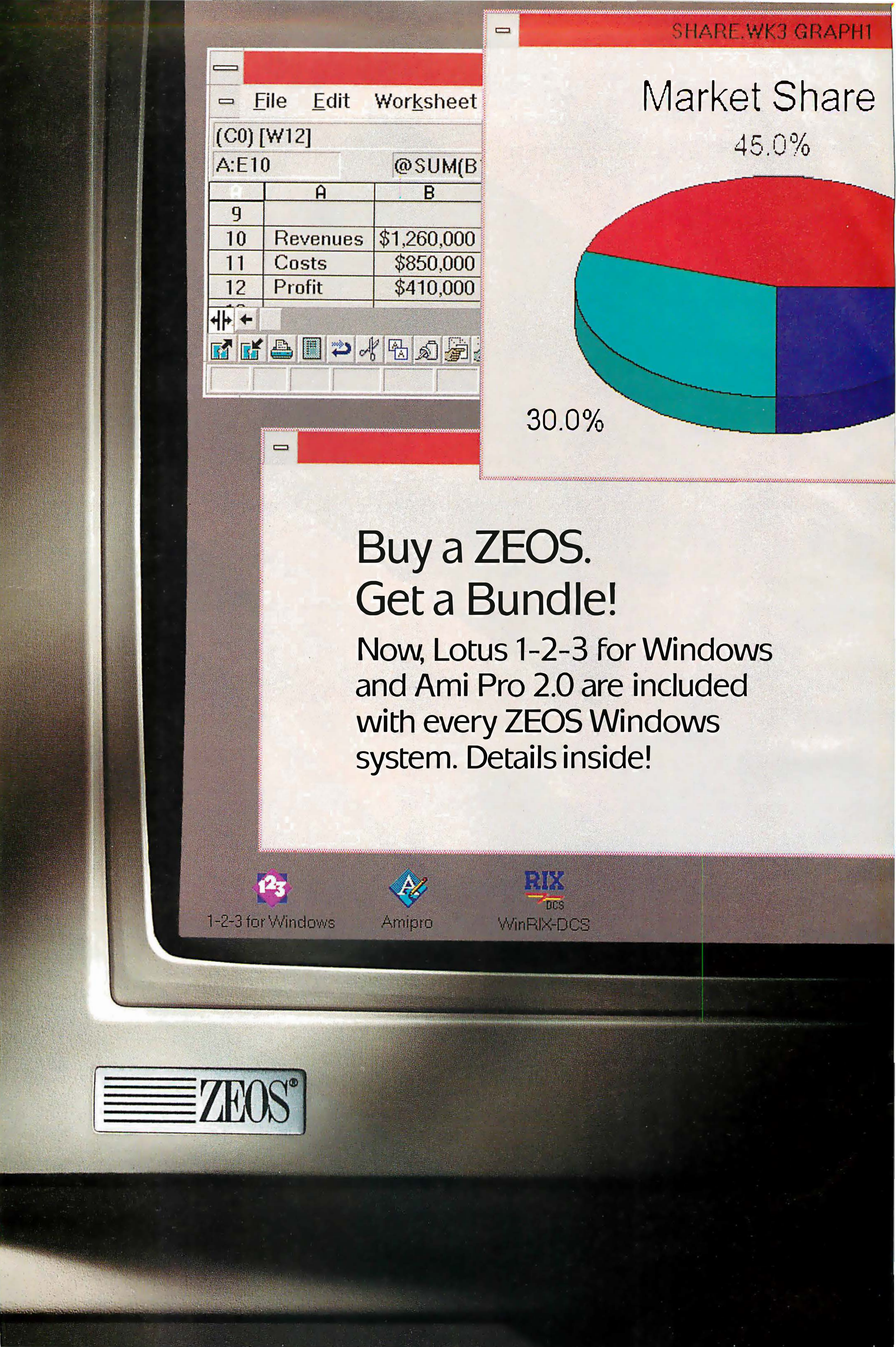
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From Demolink: See ad on page **361**
On disk: See ad on page **297**

INSIDE BYTE

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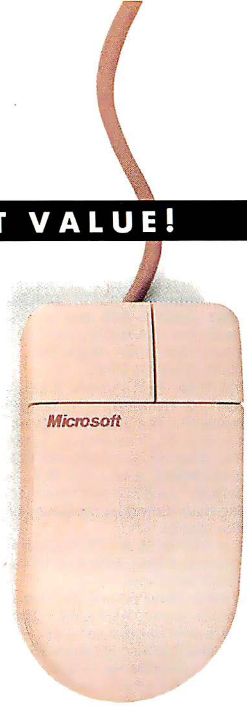
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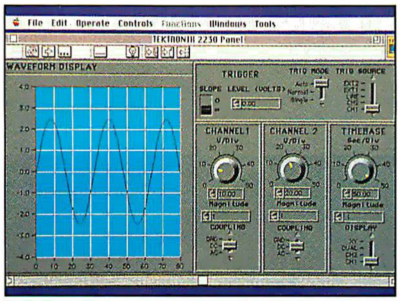
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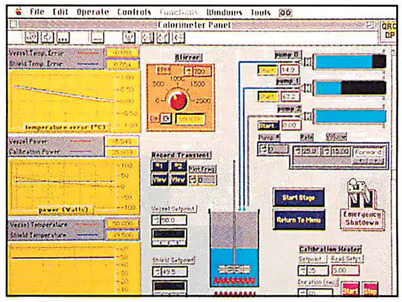


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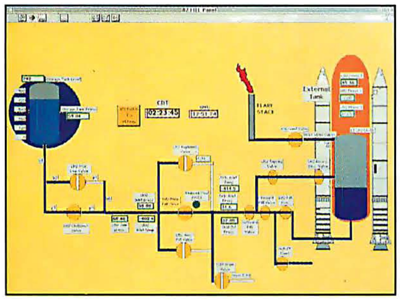
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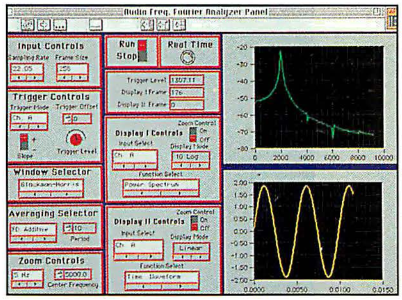
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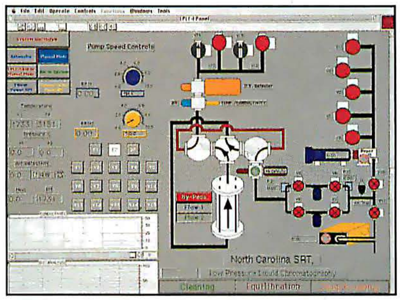
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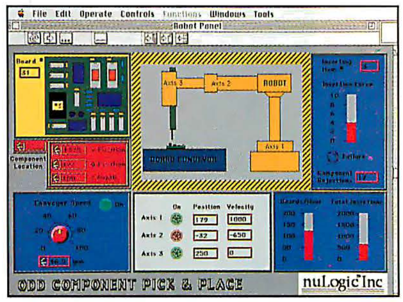
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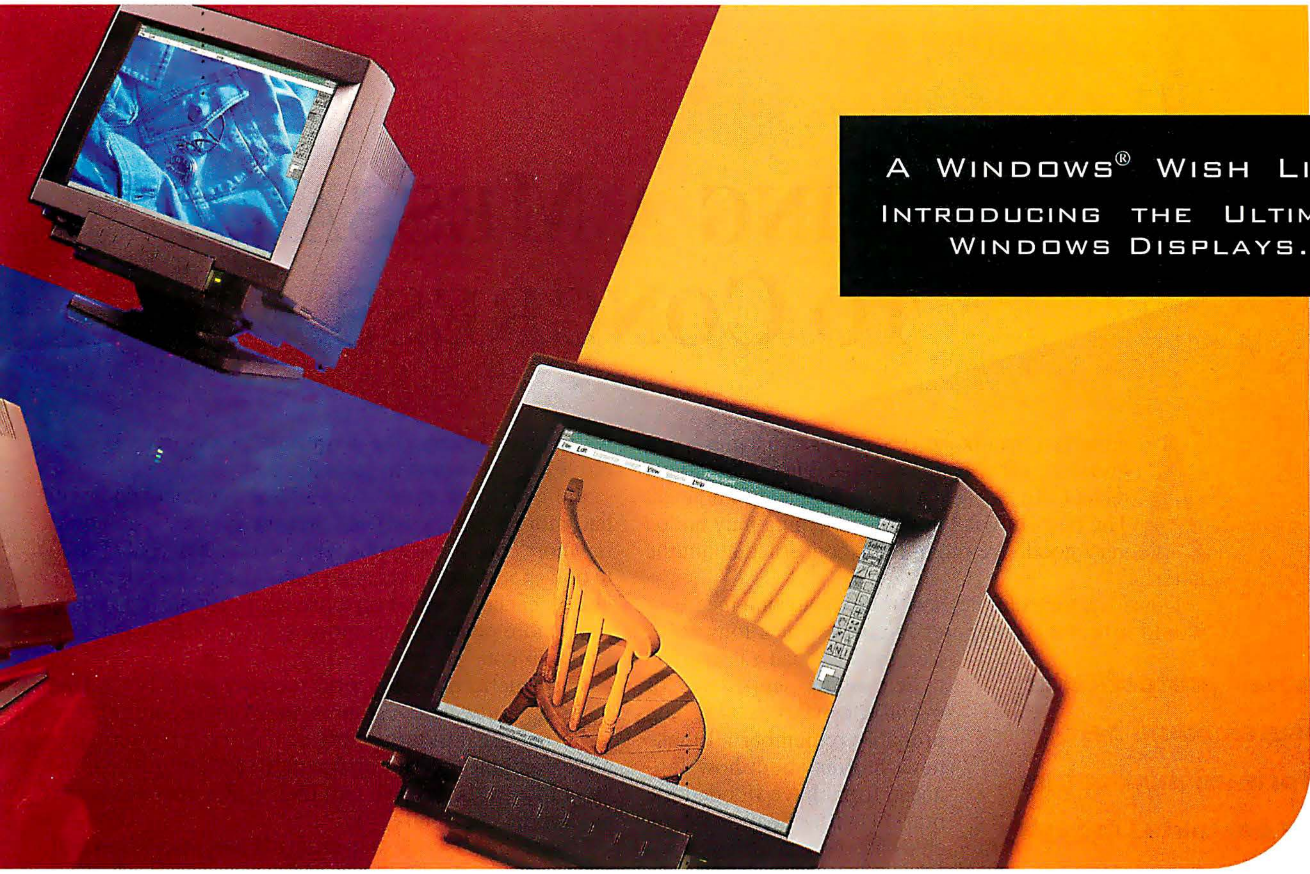
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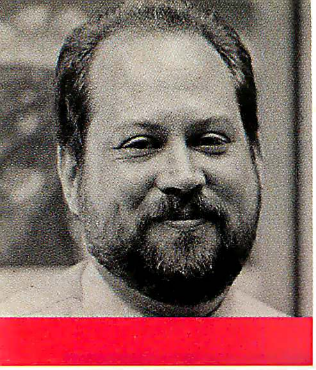
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EDITORIAL

DENNIS ALLEN

SENDING A MESSAGE TO CONGRESS

Proposed protectionist measures could halt the forward momentum of the computer industry

An election year in the U.S. means two things---one good, the other bad. The good thing is that to get reelected, Congress has to actually do something. The bad thing is that that something may not be very good. We ought to be concerned about the latter.

Consider, for example, how trade-protection measures would affect the computer industry. For a long time, Congress has had a hankering to help out the semiconductor manufacturers in the U.S. You probably remember all those news stories about how Japanese firms have flooded the market with cheap memory chips and how U.S. firms cannot compete against the "dumping" of such low-cost chips on the market.

On the one hand, it would appear that restricting imports of memory chips would help U.S. memory makers, therefore protecting the industry and jobs. On the other hand, any kind of restriction would cause prices to skyrocket, and higher memory prices would mean higher prices for systems—a complete reversal of the current trend toward commodity pricing.

Think about it this way: Just a few short years ago, there was a shortage of memory chips, and prices were naturally high. They were high enough, in fact, that a typical system came with only 1 MB of RAM—scarcely enough to run, say, Microsoft Windows or any demanding application.

It took a big drop in memory prices to spur manufacturers to produce 2-, 4-, or even 8-MB systems for less than $3000, and we've all capitalized from that. More to the point, we've bought more-powerful computers that let us run more-powerful—and more-demanding—software applications so we can better do our jobs. Now that's a competitive edge, and it's one that Congress seems willing to forfeit.

After years of promises and predictions of how personal computers would improve everyone's productivity, we find ourselves at the threshold of realizing that goal. Almost as though it happened overnight, although it didn't, we finally have user interfaces that actually make applications easy. We have applications that can use graphics as well as they can use text and numbers. We have operating-system platforms that let us run several applications at once. All of this came about because memory chips have been cheap and plentiful, and now, just as we're ready to cross the ubiquitous productivity threshold, Congress wants to slam the door.

For a moment, think about all that you could do if you had more memory in your present system. You could run more concurrent applications so that they could "talk" to one another and exchange data. You could run a larger disk cache to speed up those applications. You could run a more powerful operating system. Simply put, you could do your job better.

The benefits of having more memory go far beyond the obvious. Software developers, for example, are eager to write the gigantic programs necessary for enterprise-wide computing. And companies are raring to implement those programs so that their entire operations can work more efficiently.

Enacting protectionist measures for memory chips will halt the forward momentum of the computer market and the computer industry. Such action would stall future developments—in both software and hardware—simply because high memory prices would mean that the average computer system would have a relatively small amount of memory. In short, we would all have to spend a little more on computers to do a little less.

You get the picture. With lots of inexpensive memory, we become more productive individually and as entire companies, and that increased productivity translates into nationwide competitiveness. Does that competitiveness mean jobs? Perhaps, but I'll leave that to the Labor Department to say. One thing for sure, though, is that if trade restrictions are applied, cheap and plentiful memory is not possible.

That's less than desirable, and it's nearly intolerable. At best, it may only be shortsighted. At worst, it's just plain stupid. Trade protections rarely make sense. Moreover, Congress doesn't seem to think that voters look beyond the short-term benefits that they promise. Of course, it's not the first time that Congress has been wrong.

Fortunately, when Congress is wrong, folks can say so at the voting booth on election day. But why wait until then? By that time, the damage will have been done. The better solution is to write a letter to your congressperson. Contrary to what you may have heard, they're starved for feedback from folks like you. If you're too busy to write a letter, just tear out this page, sign it, and mail it. Either way, they'll get the message.

—Dennis Allen
Editor in Chief
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Compiled	No	Yes
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Extensible	No [1]	Yes
Create DLLs	No	Yes
Reference to API	No	Yes
Resource compiler	No	Yes
Help compiler	No	Yes
Speed (Sieve)	20.21 sec.	1.65 sec.
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[1] Visual Basic can only be extended by writing Dynamic Link Libraries in C, C++ or Pascal.
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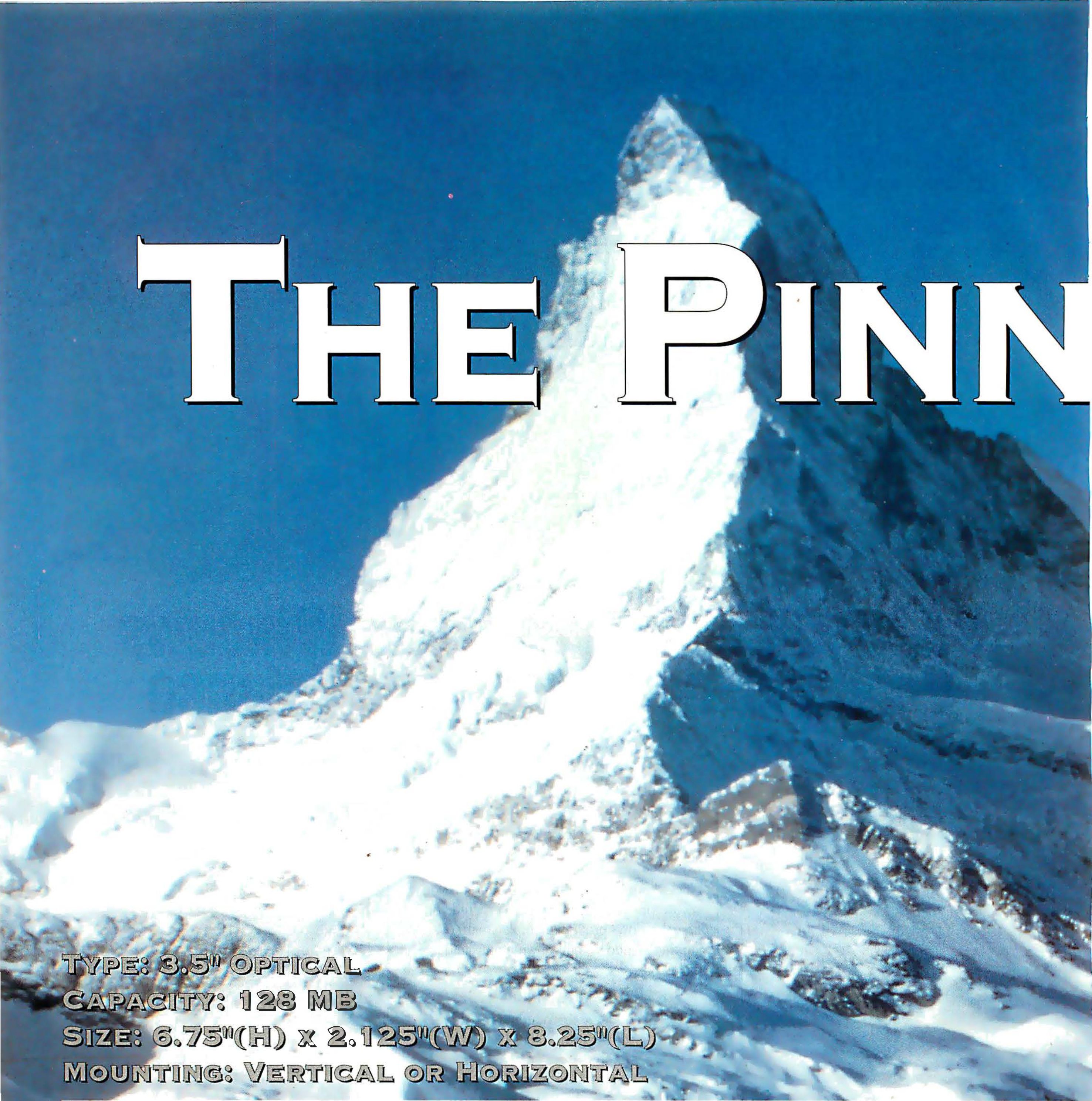
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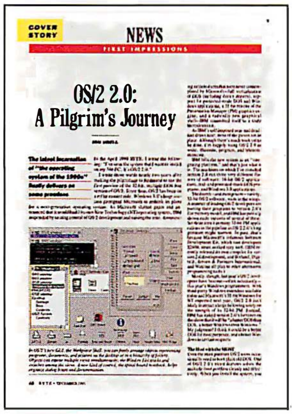
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LETTERS


COVER STORY
NEWS
FIRST IMPRESSIONS
OS/2 2.0:
A Pilgrim's Journey

Waiting for OS/2

Regarding "The Public Speaks on OS/2 vs. Windows" (November 1991), Microsoft has claimed that "the market has spoken" by choosing Windows. This is nonsense. The market has no way of knowing what it wants until products are available for purchase. The market was never offered 32-bit OS/2 2.0. If Microsoft needed to abandon something in favor of Windows 3.0, there was 16-bit OS/2 1.x, which never had much to recommend it and was rejected by the market.

Microsoft has claimed that Windows 3.x is better for the market than OS/2 2.0 would have been because it requires less-expensive hardware. This too is nonsense. No one buys a 286 machine these days, except as a minimal DOS box. Everyone is buying 386SX, 386, and 486 machines, and Windows 3.x wants as much from these as OS/2 2.0 would have, but it gives back much less functionality and performance.

For years we were told we were moving out of DOS, and then suddenly we were told to stay put and get bigger Windows instead. I hope the IBM version of OS/2 2.0 succeeds, if only to spite Microsoft.

Jim Howard
Project City, CA

What Ellen Ullman says in the December 1991 Roundtable ("What's Wrong with Unix?") is true: DOS is a "retrofit kludge." We deserve something better. When I try to generate a report in Quicken with Desqview installed, I get an "Insufficient memory" message. I have to remove Desqview to generate the report. Sure, this is just a bug. It's also a pain.

I'm pinning my hopes on OS/2 at this point and praying that IBM finally gets it out the door and that it spawns many applications.

Bill Romaine
Acton, MA

With the real OS/2 just around the corner ("OS/2 2.0: A Pilgrim's Journey," December 1991), it is ironic that Microsoft Windows has both hindered and helped OS/2: hindered, because Windows derailed OS/2's development program; helped, because until Windows, the GUI was going nowhere on the PC. Windows binary compatibility made OS/2 unnecessarily fat and delayed it even more, but this helps, because Windows capability will be what sells OS/2.

I intend to run OS/2, and I intend to program for it.

But I am not pleased that it is four years late. Nothing has held back the industry more than the Microsoft/IBM bungle of OS/2. I'll never forgive IBM for wasting time on 16-bit OS/2. And I'll never forgive Microsoft for abandoning OS/2 altogether. BYTE editor Michael Nadeau is correct (see "Why Windows Needs OS/2," December 1991). The coming battle between Microsoft's Windows NT and IBM's OS/2 2.0 is a boon to consumers. However, it's not the really interesting spectacle. More interesting will be the emergence of 64-bit operating systems as Intel rolls out—as it must—its 64-bit 80x86 chip.

Will we see another bungle from the operating-systems giants, or will they react correctly next time?

John Kominek
Markham, Ontario, Canada

I'm often bemused by the preponderance of pro–Big Blue proclamations that stream forth from your pages. I just finished laughing at Michael Nadeau's editorial ("Why Windows Needs OS/2") and Jon Udell's "OS/2 2.0: A Pilgrim's Journey" (December 1991). I laughed not because the writing was particularly humorous, but because these authors still [don't understand]. How many postponements [of OS/2 2.0] have there been? The deadline for OS/2 2.0 was December 31, 1991. Yesterday I read of IBM's planned March 1992 release of the product. Ha! IBM couldn't produce a viable package with Microsoft, and IBM won't be able to do it without Microsoft.

I'm almost ready to wager that by March IBM will proclaim some wonderful new breakthrough technology that can't be ignored and that will be developed by IBM's crack OS/2 2.0 team. And of course OS/2 2.0 will then be ready by May 1995 or soon thereafter, so users shouldn't switch to Windows!

John Caporale
West Chester, PA

High-Level Praise

I am very glad to see your six-part series by Doris Appleby on higher-level languages ("Classic Languages," beginning in September 1991). We read much about C these days, but higher-level languages offer enormous advantages to applications software developers as well as to maintenance programmers.

One advantage is that these programs are written in a fashion similar to the way people think and thus are very readable. Another advantage is that these programs can be transported from a platform manufactured by one vendor to a platform made by a different vendor, providing that both vendors have conformed to the appropriate standards. In addition, the error-handling routines for the higher-level languages are very sophisticated and accurate. I have yet to see competent error-reporting routines for C.

C should be used to create operating systems, drivers, compilers, linkers, and interrupt handlers. For

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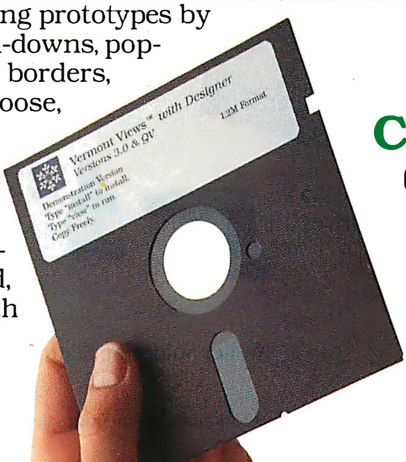
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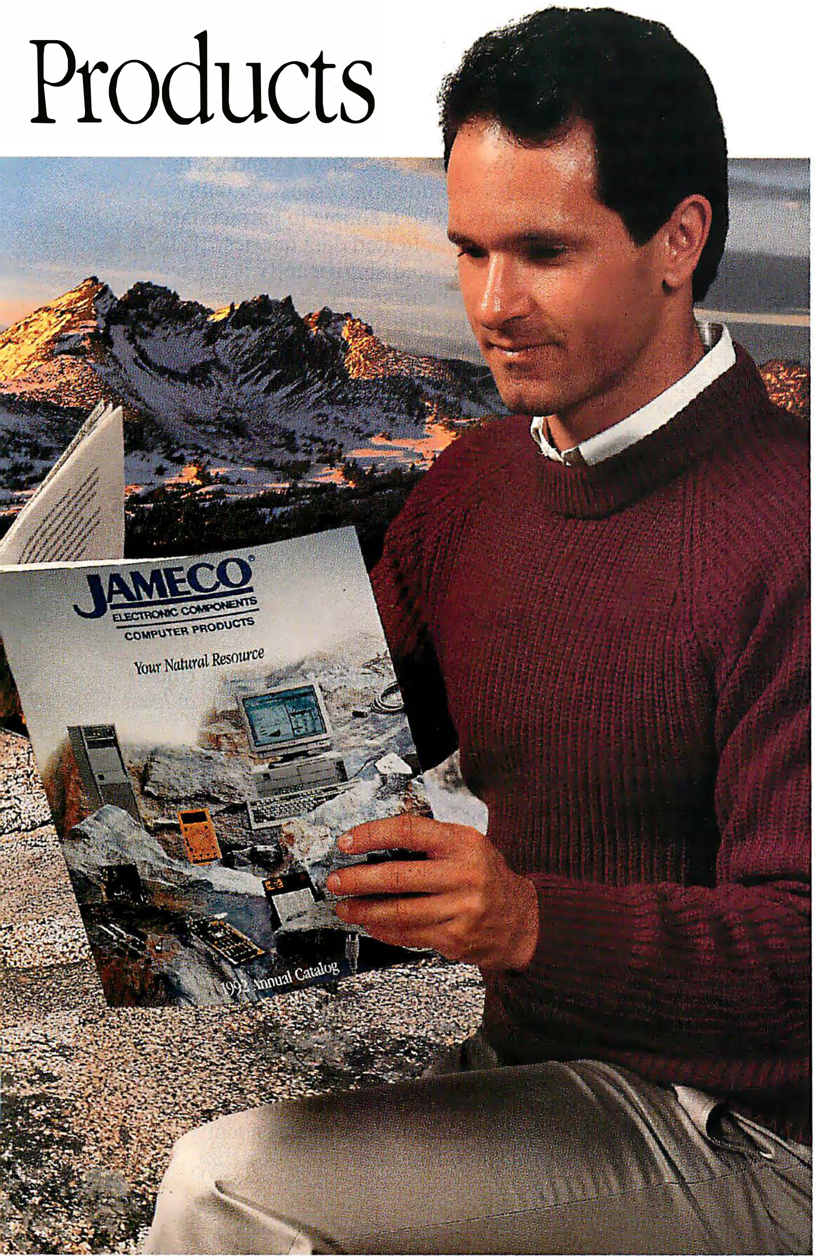
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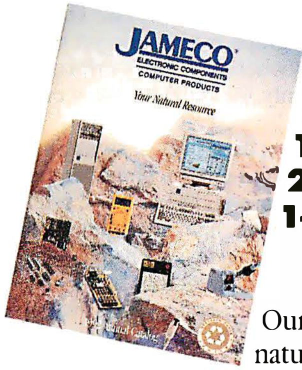
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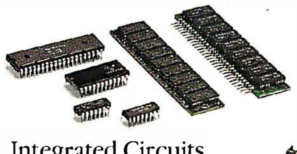
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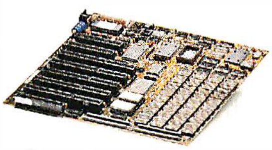
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applications, though, the higher-level languages are by far the better choice.

Leonard M. De Ball
Glen Ellyn, IL

Defining Interoperability

What a wonderful article "Integrating Distributed Information" (November 1991) is. The opening line of the second paragraph is so subtle yet so incredibly important: "Everywhere you look, information hides within data, waiting only for the right set of circumstances to reveal itself."

In Ontario, road crews used to post signs ahead of major construction listing a contract number and completion date for the work. New signs include a brief descriptive message regarding the work, along with the completion date. What a wonderful change. The original signs were a great example of data, and the new signs are a great example of information. Until the new signs came, everyone considered the old signs to be informative because they had information written on them. Ah! Not anymore. Now someone has shown us what information really is, and we can see that there is in fact a difference between data and information.

Kevin Stumpf
Kitchener, Ontario, Canada

It's obvious from reading "Interoperability: The Unfulfilled Promise" (November 1991) that interoperability has become more important as more and more corporate data is distributed off mainframes onto desktop systems. But I am left wondering whether the quest for interoperability may stem from a failure to adequately distinguish between the nature of data typically kept on small computers and that residing on larger systems.

Consider an IBM 3090 mainframe handling data and global data processing. A centralized MIS bureaucracy might dream of linking a local database of clients maintained by the New York office with local client databases kept by field offices, all of which might very well be sitting on some combination of minicomputers, Macs, and PCs. Even if a field office harbors data seemingly equivalent in structure to that independently gathered in New York, there is no guarantee that the data is equally meaningful, since there is not likely to be any commonly defined protocols for collecting the data. For these and other reasons, desktop-resident data is often valuable only at this localized or "micro" level.

Ultimately, "noninteroperative" computing seems to entail redefining what constitutes legitimate and valuable data processing. We should be careful not to obviate the economies obtained in the desktop revolution by demanding that small systems be defined merely as distributed versions of mainframe technology, as the quest for interoperability seems to tacitly demand.

Keith E. Risler
London, Ontario, Canada

There is an error in "Transparent Data Exchange" (November 1991) and a few possible misconceptions. AutoImport is not on the market. Tangent Group acquired the technology and, after evaluating what the market needed, developed refinements to serve two different computing environments: PC file server and mixed platform. Avenue is adapted to the PC file-server environment and Catapult to the multiplatform environment.

Steven J. Vaughan-Nichols comments, "It isn't transparent, but at least it's easy." If this means that you can't get Lotus data when you're in dBase, transparently, it's accurate. With Avenue and Catapult, the PC user can choose a keyword that will initiate action on host data. The user needs no knowledge of host operations to get host data. The mask capability refines data access further and makes it even more accessible to end users.

Vaughan-Nichols concludes the discussion with "while both programs make it simple to extract data ranges, they can't do complicated data queries. . . . " One of the areas we enhanced significantly is the search capabilities so that a user can specify criteria or values to select data. Several of these can be put back to back to sift through multiple levels of data.

Overall, the tone and direction of the whole special section were informative and interesting. We applaud your efforts at cutting through the glitz with the knife of practicality.

Posy Gering
Tangent Group, Inc.
Bothell, WA

Revise Jerry's Rule?

I would like to extend Jerry Pournelle's famous rule to this: "One person, at least one processor, *and at least one mass-storage unit*."

There is the ugly new phenomenon of diskless workstations, which provide end users with processors but deny them the space to store work unless the network and the central server are running. This reduces the local CPU to the level of a smart terminal, with all the drawbacks of one main CPU.

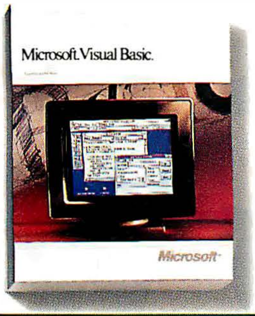
The network with diskless workstations is as unproductive as a mainframe network. The local workstations will use the server for any dumb I/O and will stay idle when they need information and the server is overloaded or down. The same justification to get rid of the old mainframe will appear in this type of network. The users will have (as they have now) the right claim that with local mass storage they can unload only the pieces of information they need, work on them independently, and upload them again when finished.

Ze'ev Atlas
Teaneck, NJ

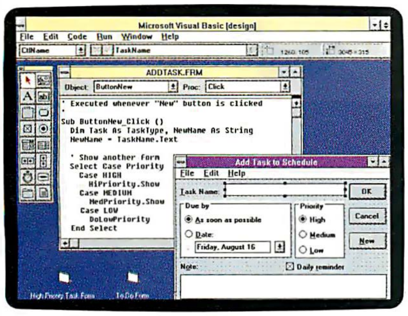
I'll give some thought to the modification: One user, at least one CPU, and nowadays, yes, at least one mass-storage device. —Jerry Pournelle

FIX

LANFax Redirector ("Network Fax Servers Come of Age (Slowly)," December 1991) is stand-alone software that supports industry-standard fax boards. We inadvertently described it as a hardware/software bundle. ■



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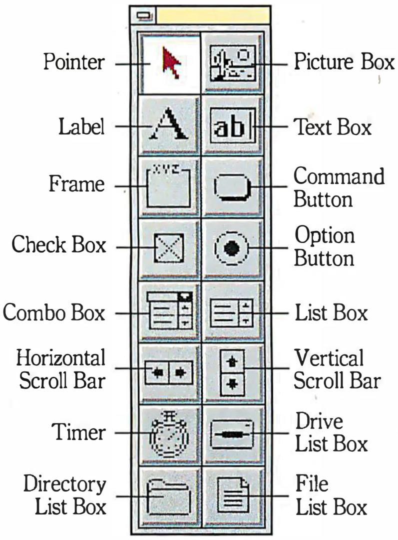
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At the 1991 Spring Comdex/Windows World, the editors of BYTE *judged Visual Basic the "Best of Show." In the July 1991 issue of* BYTE, *Editor-in-chief Fred Langa called Visual Basic "a milestone product."*

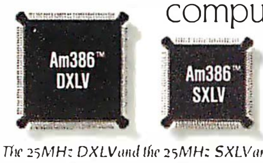
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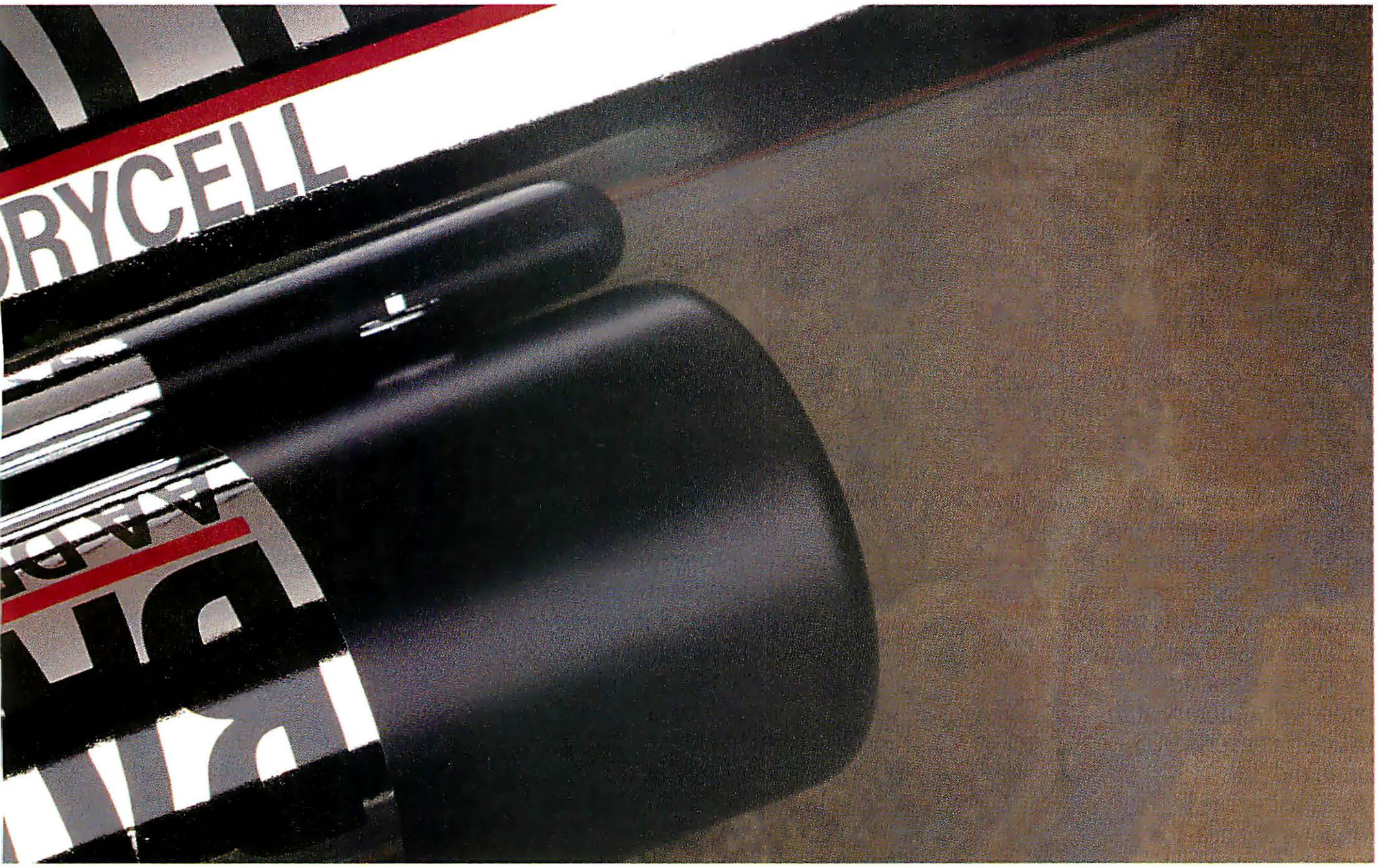


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NEWS

MICROBYTES

Novell Gets Serious About Unix

Novell might be justified in thinking that NetWare will dominate for years to come. But as Microsoft's 32-bit, scalable Windows NT (New Technology) operating system inches closer to reality, it's clear that Novell is concerned about the long term. Windows NT, with its integral networking capabilities, could obviate the need for NetWare. The solution: Novell is throwing in its lot with Unix.

Long the dominant client/server network operating system for the world of DOS-based PCs, Novell's NetWare is now being moved over to Unix through partnerships with Hewlett-Packard and the Unix Systems Laboratories (USL). In the past, Novell's Portable NetWare for Unix provided a subset of NetWare's full capabilities and incomplete connectivity between Unix and DOS. Now NetWare will be tightly integrated with Unix. One benefit: The difficulties of integrating LANs based on TCP/IP and Sun Microsystems' Network File System protocol with NetWare will become transparent.

The deal between HP and Novell will finally bring NetWare to a RISC-based Unix environment. The two companies plan to work together to port NetWare onto HP's Precision Architecture-RISC architecture, which is the basis for the blisteringly fast Series 700 workstations and servers. The software is expected to be available sometime in 1993. Darrell Miller, Novell's executive vice president of marketing and services, said that the two companies decided to support PA-RISC because of its speed and that producing a native version of NetWare will allow NetWare loadable modules to run.

The deal with USL may prove to be more strategically significant, since it could open up the whole Unix world, not just HP's corner of the market, to Novell. Novell and USL will form a joint venture called Univel in San Jose, California. Univel's mission will be to create a standard implementation of NetWare for USL's Unix System V release 4.0. Univel's products—the first of which will reportedly be available in the first half of this year—will arrive first for Intel-architecture machines. Other possible platforms include Advanced Computing Environment and SPARC machines.

The USL deal may have more to do with battling Microsoft than with integrating heterogeneous LANs. The announcement sheds light on why Novell invested in USL last year: Novell wants to hold onto the Intel-based market, and if that means jumping to Unix, so be it. Says Rikki Kirzner, a senior analyst at Dataquest, NetWare could become to Unix what LAN Manager is to OS/2 and Windows NT. Unfortunately for users, a protracted battle between Windows NT and Unix could further postpone the era of truly transparent interoperability.

—Owen Linderholm and Andy Reinhardt

Clarion and Jensen & Partners to Merge

Clarion Software (Pompano Beach, FL), developer of database applications development tools for DOS-based PCs, and London-based Jensen & Partners International, developer of the TopSpeed language products, have announced an intent to merge. Clarion's flagship product, the Clarion Professional Developer, will be integrated with JPI's tools, which include optimizing compilers, link technology, and an interactive debugger. The two companies had already planned to include JPI's compiler/linker technology in the Clarion Professional Developer 3.0, scheduled to ship this month.

To accomplish the merger, Clarion stock will be issued to JPI stockholders. JPI's development staff will remain in London under the name TopSpeed Institute.

—D. L. Andrews

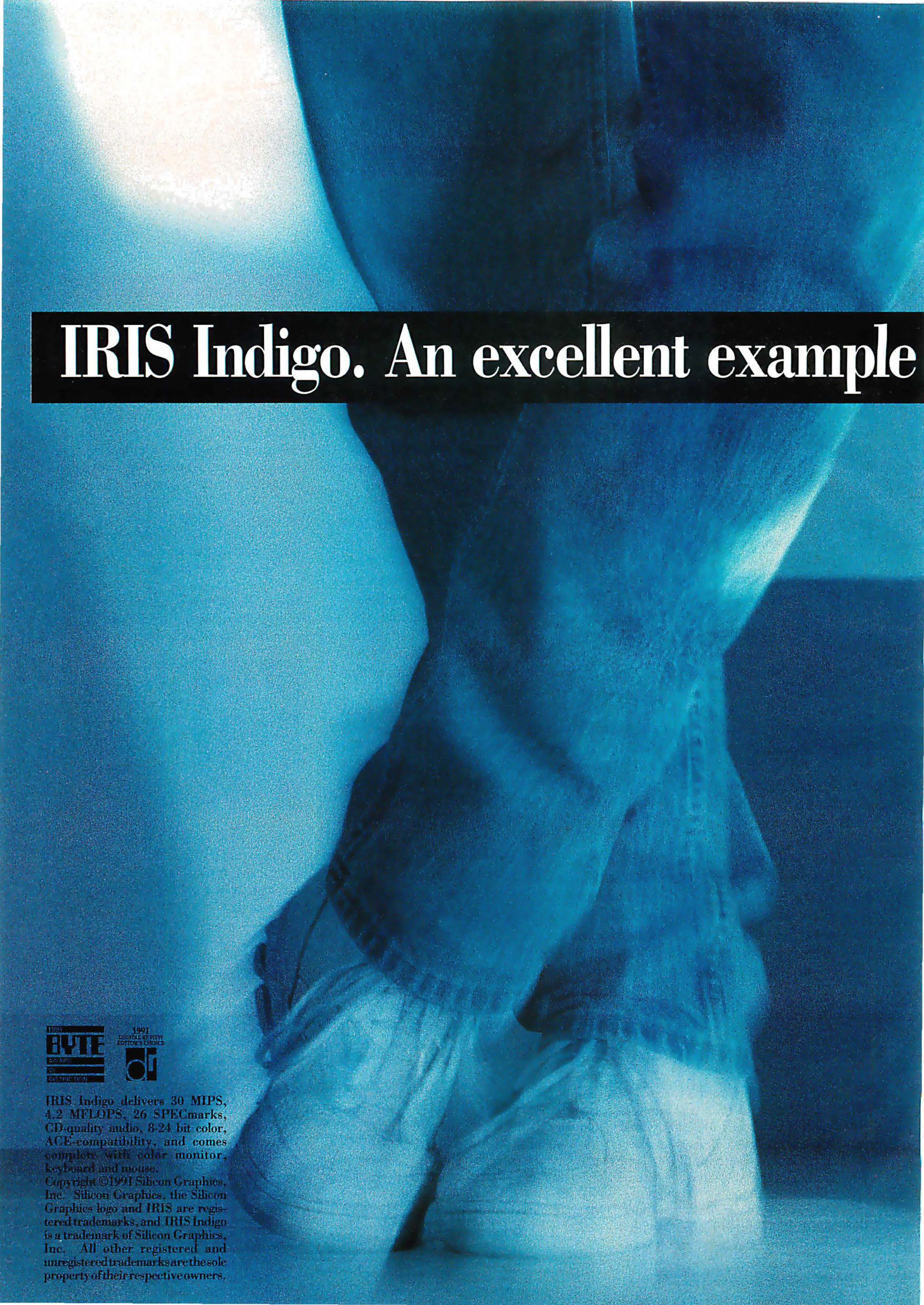
NANOBYTES

The most intriguing and puzzling aspect of Novell and USL's Univel deal is that the partners hinted that they may produce the long-rumored **Unix Lite**, a scaled-down version of the operating system that would be shrink-wrapped for the desktop. USL has been thought to be developing this technology with **Compaq**, but now it will apparently fall to Univel. Compaq's role is unknown at this time. Robert Kavner, chairman of USL, said the software will appear this year. □

Bruce Barrington, Clarion Software's chairman and chief engineer, said his company's merger with Jensen & Partners International "allows us to offer the best in languages together with the best in database technology. Until now, the database developer's choice has been C for speed or either Clarion, dBase, Paradox, or Clipper for programming ease. Now Clarion can offer the same speed and compactness as a C program." □



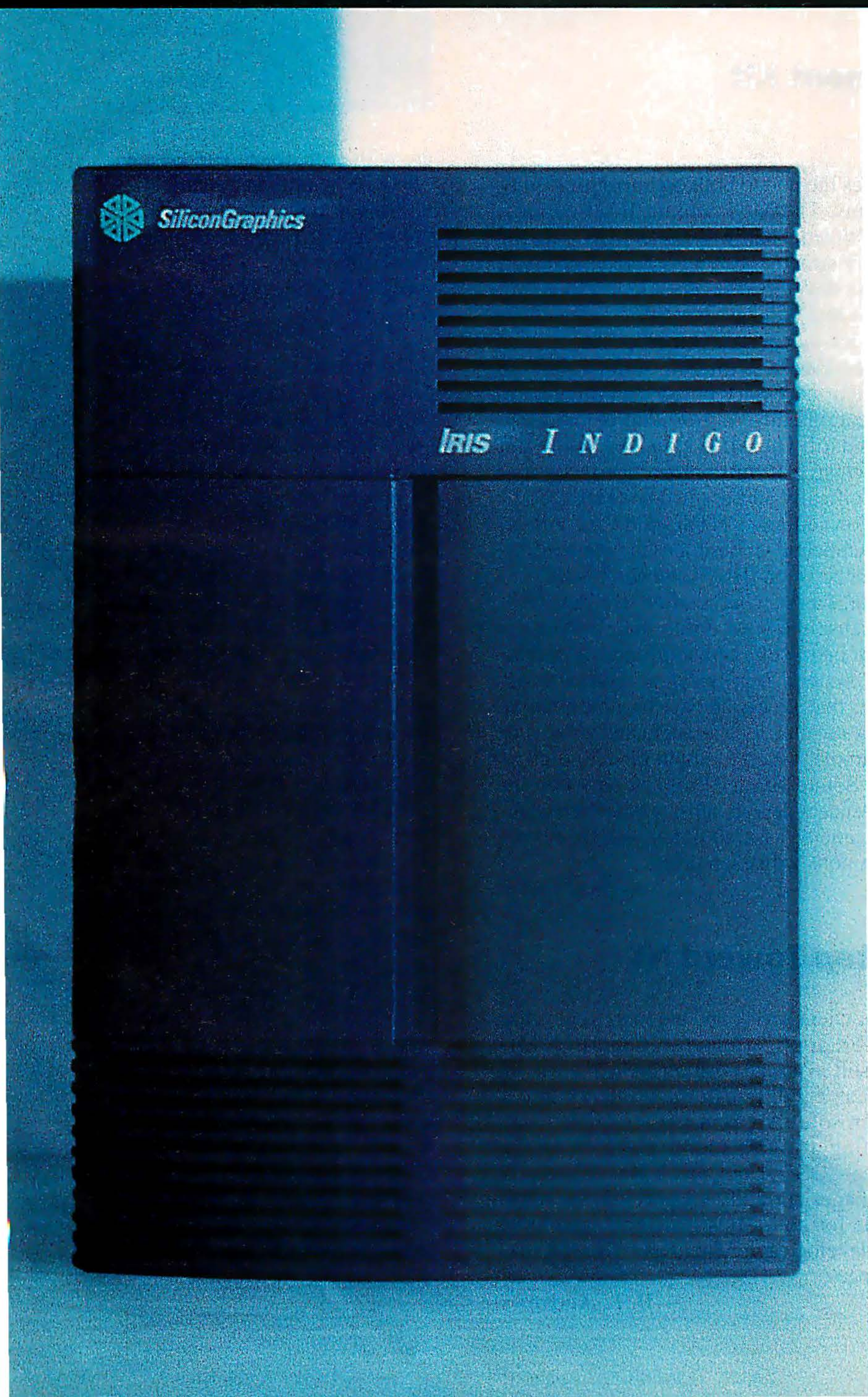
Ray Noorda, Novell's CEO, has a different view on corporate stockholders. "During our operations, we think of the **customer first, employees second, and shareholders third**," he said at the time of the Hewlett-Packard and USL announcements. Noorda's approach contrasts sharply with the business model that puts shareholders first. Novell shareholders aren't doing too badly: Novell reported **record revenues** for 1991 of $640.1 million, up 29 percent from $497.5 million in 1990, and profits of $162.5 million, or $1.10 per share, up 72 percent from 1990's $94.3 million net. □


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NEWS

MICROBYTES

Apple Admits Floppy Drive Problem

Apple has admitted that a start-up production glitch has affected the floppy drives in the new portable PowerBook 140s and 170s to the point where the company must replace the drives. Most of the failures have been in the drives in the 140 model.

The internal floppy drives on some early production runs fail to operate unless screen brightness is turned down all the way, which makes the machine far less useful. "We made a production change before the holidays that adds shielding to the floppy drive, and that seems to eliminate the problem," an Apple representative said. "We are fixing the affected drives under warranty at no charge to the consumer and encourage those with problems to call the Apple Customer Assistance Center at (800) 776-2333 to find their nearest service location."

—Larry Loeb

IBM's Multimedia Development Kit Acknowledges Two Worlds

IBM is supporting the formats of two different multimedia platforms with the beta release of its 32-bit Multimedia Presentation Manager/2 Development Kit. The prerelease MPM/2, available from the company's operation in Boca Raton, Florida, is priced at $100 and provides developers with early access to documentation, tools, and code samples for the Multimedia Extensions to OS/2 2.0.

Mark Tempelmeyer, IBM's manager of multimedia system software, acknowledges the importance of standards in the growth of multimedia and says that the MPM/2 extensions support standards such as the Media Control Interface (MCI) command set and the Resource Interchange File Format (RIFF), which are part of the multimedia extensions to Windows 3.0. IBM belongs to the Interactive Multimedia Association instead of the Multimedia Marketing Council, an organization created by Microsoft, Tandy, and others to promote the Multimedia PC (MPC) standard. Other IMA members include Apple, Sony, and Philips.

By supporting command sets, formats, and functions such as MCI and RIFF, IBM gives the nod to both organizations' platforms. The MCI command set controls multimedia hardware in an MPC, and the RIFF structure can incorporate other formats developed independently of RIFF, such as a Windows metafile or a Windows device-independent bit-map file.

The IMA's definition of the minimum system necessary to run multimedia applications differs from that of the MPC standard. The MPC standard, while not preclusive of full-motion video, does not specifically address it. The IMA specification addresses NTSC and PAL video.

Tempelmeyer describes the main difference between IBM's and Microsoft's offerings as synchronization. He states that because the IBM multimedia product is built on top of a true multitasking operating system, it provides additional functions that are used to synchronize multiple data streams, such as audio and video. For example, a stereo output device, such as the Sound Blaster Pro, can play two independent data streams, one on each channel, and be assured of keeping them synchronous with each other.

—Matt Trask

Microsoft Takes Another Step Toward NT

Microsoft's second prerelease version of the Microsoft Windows 32-Bit Development Kit includes code to develop for and run on Mips RISC and Intel systems, marking the first time the company has released tools for a non-Intel-based platform.

A Microsoft spokesperson said that the Development Kit has been released to about 100 select software developers and corporate customers.

The kit includes an integrated LAN Manager client/server and the tools to develop 32-bit applications for Windows. Microsoft's official position on Windows NT is that it will transform Windows into a Microsoft LAN Manager server platform, adding a fourth server platform to the three—OS/2, Unix, and VMS—that LAN Manager currently supports. To develop code for both Mips platforms, you have to develop on a Mips R4000-based machine.

—D. L. Andrews

NANOBYTES

How will Microsoft's forthcoming Windows NT operating system compare to Unix? According to Microsoft chairman and CEO Bill Gates, NT pretty much *is* Unix. With its **Posix standard compliance**, Gates claims NT will be as compatible with the leading versions of Unix as they are with each other. The advantage of NT, Gates says, is that it will sell millions of units, more than any flavor of Unix. He also said that Microsoft may offer a limited voice-recognition capability for Windows this year. □



Starting next month, **Intel** will cut prices of its 386 processors by as much as **35 percent**. It will also increase research and capital spending this year. The company says that the cuts are inspired by competition from AMD and that Intel will concentrate on generating revenue from its 486 chips and 386SL chips for notebooks. In the same month that Intel revealed the looming 386 price cuts, AMD CEO Jerry Sanders said in a teleconference for financial analysts that AMD will ship a 486 product for revenue this year. □

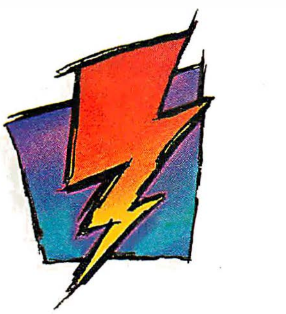
Live from Merrimack, New Hampshire, it's Desktop Direct from DEC. That's right, DEC is in the midst of a "multimillion dollar push" to start selling systems such as the 386SX, 16-MHz-based DECstation 316SX, 486SX-based DECpc 433 Graphics Power Package, and the 486SX-based DECpc 433 Graphic Power Plus Package at prices as low as 50 percent of the list price. Resellers and value-added resellers can take advantage of the offers. For more information, call (800) 722-9332. A DEC representative said that the offers won't apply for SCO Unix systems. "Unix variations are a much more intense technical environment," he said. □

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NEWS

MICROBYTES

Vendors Announce Electronic-Imaging Standard

A new standard for the graphics and imaging world promises to make it easy to directly import captured images into applications and to simplify developers' support of the many input devices on the market. Many of the companies that are involved in electronic-image processing have jointly defined a standard programming interface, called CLASP (Connecting Link for Applications and Source Peripherals), so that developers won't have to program a set of drivers for each scanner or digital camera on the market.

The computer-imaging world relies on two capabilities: the conversion of images among different file formats and the ability to capture images electronically from an input device (e.g., a scanner). Although a standard doesn't exist for image formats, most applications now support a small range of preferred image formats. Because most graphics-related applications can convert among these formats, the image-format problem is at least manageable.

Unfortunately, except for the forthcoming CLASP standard, the industry hasn't agreed on a way to import images. Thus, every application that wants to bring in an image must provide its own extensive set of drivers to support every possible input device; otherwise, the application has to rely on using a separate image-capture program to import the image in one of several possible file formats. The latter solution is inelegant for the user, the former is laborious for the programmer, and neither helps if you just want to directly scan an image into the company newsletter.

CLASP is designed to address all these problems. The standard CLASP application programming interface (API) will let applications use one set of device drivers that will support all compliant peripherals. When applications such as PageMaker support CLASP, you will be able to select a menu item to acquire an image, capture the image using your scanner, and paste it directly into a document without leaving your application.

This set of standards is being finalized. The preliminary name of CLASP is likely to change soon to TWAIN, which one observer said means Toolkit Without An Important Name. Whatever the name, the standard has the support of leading hardware and software companies, improving its chances of becoming widely adopted.

CLASP is a multiple-platform and multiple-device API. It is initially targeted for the Mac and Windows environments. OS/2 and the X Window System may follow.

—Owen Linderholm

Lotus Not Consolidating DOS Spreadsheets... for Now

Sources outside of Lotus Development have told BYTE that two factions are at war within Lotus over how to deal with the DOS spreadsheets. Recognizing that the bifurcation causes market confusion, some people argue that Lotus 1-2-3 release 3.1 should be eliminated—especially since its level of functionality is supplied by 1-2-3 for Windows—and 2.3 should be enhanced to better compete with Quattro Pro. Release 2.3 runs on XT-class machines, so if it were eliminated, Lotus would have no low-end offering.

Other people apparently believe that Lotus needs to keep both products, at least until the Windows version gains popularity and more XTs are retired. Rewriting 2.3's assembly language code to provide better memory management and allow multiple-page spreadsheets is said to be an enormous task, so keeping 3.1 alive for 386-class users may make more sense in the short term.

The release 3.0 architecture, which is the basis for all of Lotus's non-DOS implementations of 1-2-3, has proven very successful and portable. But the old 2.x architecture keeps hanging around—and it apparently makes up 55 percent to 60 percent of new DOS spreadsheet sales—so this is a problem Lotus will have for a long time.

Lotus asserts that it is not combining its two DOS-based spreadsheets into a single product—or at least not now. A Lotus spokesperson said, "Both products play a significant role. We're not combining these products."

According to Lotus, 1-2-3 release 3.1 now accounts for 40 percent to 45 percent of the company's worldwide sales in the DOS spreadsheet market. Lotus is now working on new versions of both products, a spokesperson said, and although the company had considered consolidating the products in the past, a consolidation is "not in the cards in the near future."

—Andy Reinhardt

NANOBYTES

A manufacturer active in the Mac II market is now shipping a touchscreen for the Mac. **Edmark** (Redmond, WA) has redesigned its $335 TouchWindow to work with Mac monitors via the Mac's Apple Desktop Bus port. You can use the Mac's mouse concurrently with the TouchWindow.

The TouchWindow works with any Mac application and lets you use your finger to access pull-down menus, make selections, move objects, and draw. The screen is attached to a Mac monitor with adhesive strips. You can remove the screen from the monitor and use it as a stand-alone graphics tablet. Edmark recently began shipping a version for PC compatibles. An Amiga version is due this summer. □

Rear Admiral Grace Murray Hopper, 85, a pioneer in the development of computers, coinventor of the COBOL programming language, and the Navy's oldest serving officer, died in January at her home in Arlington, Virginia, of a heart attack.

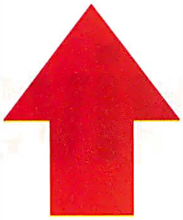
Hopper, a graduate of Vassar with a master's degree and doctorate in mathematics from Yale, joined the Navy in 1943. She was the first programmer on the world's first large-scale digital computer, the Navy's Mark I. She continued as a programmer on subsequent wartime Navy computers.

Following World War II, Hopper transferred to the Naval Reserve but continued her work in computers. She was recalled to active duty in the Navy following her retirement from the reserves and was kept on active duty for the next 20 years through a series of congressional and presidential orders.

In 1991, Hopper was awarded the National Medal of Technology by President Bush. She was known for her contrary lifestyle. Her office at the Navy Data Automation Command featured a clock that ran backward. Until her death, Hopper was a senior consultant for DEC. She was also a contributor to BYTE. She will be missed. □

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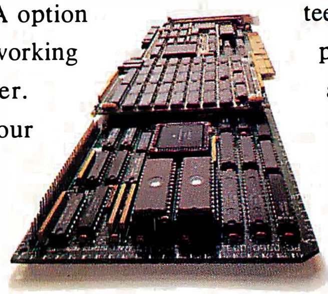
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1. # SIMM sockets standard	16	4	4	NEC
	16	4	4	NEC
2. Maximum RAM capacity	64	64	80	AST
	112	64	80	NEC
3. Internal hard-drive storage capacity	2.7GB	1GB	420MB	NEC
	4GB	4GB	2.4GB	Tie
4. Power supply	285W	240W	167W	NEC
	388W	355W	300W	NEC
5. Internal fans	3	1	1	NEC
	4	2	2	NEC
6. Snap-in device rails	Yes	No	No	NEC
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NEWS

MICROBYTES

Poqet Computer Licenses Nestor Handwriting-Recognition Software

Poqet Computer has licensed the NestorWriter handwriting-recognition software from Nestor (Providence, RI) for use in pen-based products now under development by Poqet. NestorWriter software operates with DOS 3.3 or higher, which allows integration of current DOS-based applications and offers a stable platform for new applications development.

In addition to a user interface and handwriting recognition, Nestor and Poqet are developing a complete application programming interface (API) toolkit that third-party developers can use to create pen-centric DOS applications. The software will include mouse emulation and electronic ink for signature capture and for the creation of bit-mapped images. A Nestor representative said that with the toolkit, developers will add pen-recognition capabilities to their DOS applications through pop-up, pen-input windows.

The licensing of NestorWriter is part of Poqet's strategy to provide a portable platform to users while offering flexibility to programmers so that they can develop DOS-based, vertical applications, as opposed to developing for data-collection devices that are based on proprietary operating systems. NestorWriter and the Nestor pen user interface are designed to provide robust pen-computing functionality in all classes of pen-based computers, including 16-bit (using 8088/286 architecture) and 32-bit computers.

Nestor says you can use its handwriting-recognition engine in applications developed for situations where careful hand-printing of characters is not practical. NestorWriter combines handwriting-recognition accuracy for first-time users with on-the-fly learning capabilities that adapt to a user's handwriting style, Nestor says.

The Nestor/Poqet API toolkit is available to developers direct from Poqet. The Poqet deal is nonexclusive, and Nestor is discussing similar agreements with other hardware manufacturers, according to a Nestor spokesperson.

—D. L. Andrews

IBM's Kuehler Promotes Partnering Efforts

In a meeting with securities analysts to explain IBM's recently announced restructuring plan, president Jack Kuehler promoted the company's growing effort to form alliances with leading partners, saying the business model IBM used in the 1960s and 1970s is now "a strategy for extinction."

Kuehler explained why IBM has sought to work with companies such as Apple, Motorola, Intel, and Siemens-Nixdorf. "We can leverage each other's core competencies," he said. "We can share the expense and risk of these steep investments." Despite IBM's huge size, he noted, its 50,000 worldwide competitors "collectively have far more money, capital, and talent than we could ever muster."

Through its joint venture with Siemens, IBM is sharing 16-Mb memory-chip production and 64-Mb chip development. Kuehler also said that IBM is working on a 256-Mb chip. The partnership between Display Technologies and Toshiba will produce active-matrix color displays. The Motorola and Intel partnerships will produce new IBM RISC and 80x86 CPUs.

—Andy Reinhardt

SAS Institute Favors Windows over DOS

SAS Institute, maker of the widely used statistics package, is contemplating abandoning further enhancements of its DOS product. According to spokeswoman Hilary Yeo, the company will release a Windows 3.0 version of its software in June and will then encourage PC users to move to the Windows- and OS/2-based versions of the package. SAS will continue to license and support the DOS versions, but the company is not likely to continue enhancing them.

SAS says that it's moving to Windows in response to customer demand. However, many statistics-software users are in academic settings, where money for hardware is scarce.

Graduate students and instructors won't relish having to buy a 386 to get a new version of SAS, but vendors can't be expected to carry DOS forever. Benign neglect of the DOS platform is probably inevitable over time. ■

—Ellen Ullman

NANOBYTES

IBM plans to introduce new notebooks, laptops, and high-end servers early in the year, company president Jack Kuehler said.



"In software, **we have clearly put our reputation on the line,"** he said, referring to OS/2 2.0. The operating system was delivered in late December "to customers who want to roll out code early," and it will ship commercially in March, as previously stated. IBM will "build volumes as aggressively as possible," he said. Kuehler also said that the object-oriented Taligent operating system IBM is codeveloping with Apple is slated to ship in 1994. Previously, estimates had ranged as late as 1995. He also said that IBM does not see uses of RISC CPUs confined to the computer industry. "Consumer electronics, for example, is not out of the question." □

Not long after Kuehler made those comments, Apple chairman and CEO John Sculley said that Apple will introduce **consumer-specific versions of its low-end Mac products** in the U.S. during the second half of 1992. The company also plans to introduce two lines of CD-ROM-based desktop multimedia Macs: one for the consumer channel and the other for the company's traditional PC channel, Sculley said. These CD-ROM systems will be based on System 7.0 and QuickTime multimedia technology. They should ship in time for the 1992 Christmas season. □

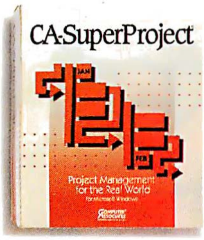
IBM is internally showing **Mac applications running under OS/2.** The technology to implement this latest feature is coming out of the Taligent group, a source said. IBM could neither confirm nor deny the existence of such technology, and the source said it wasn't clear how it was being accomplished. ■

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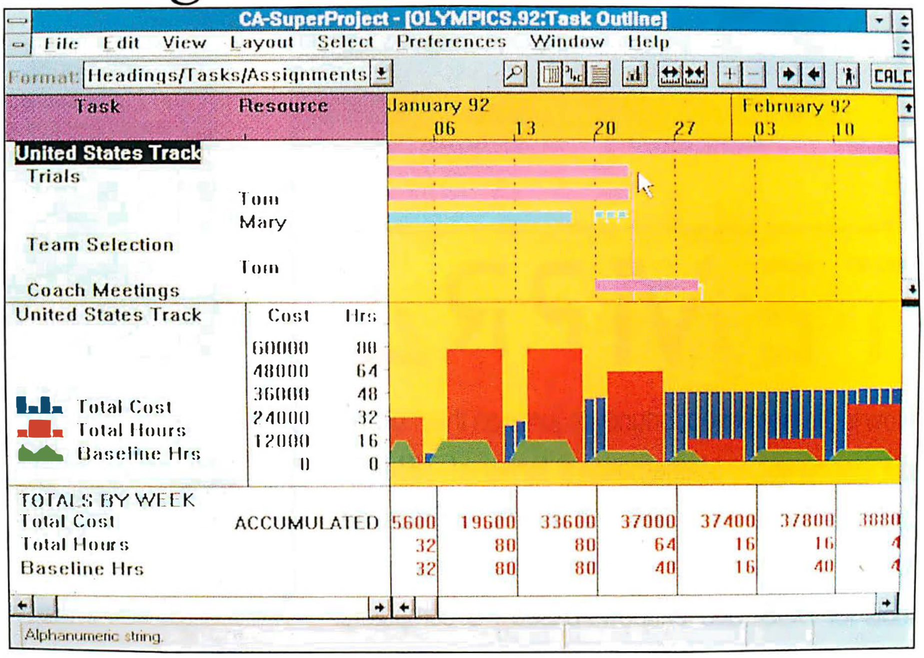
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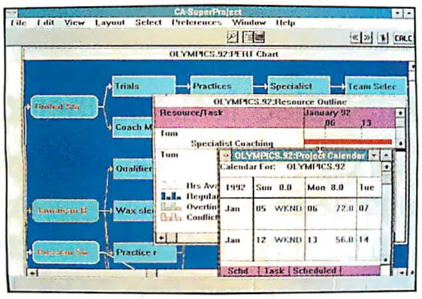
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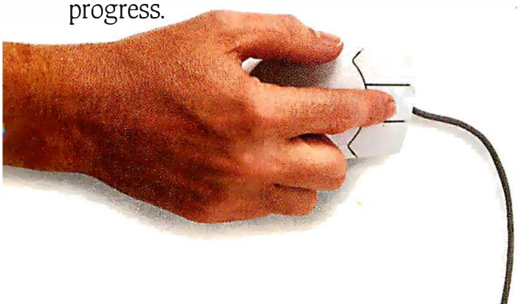
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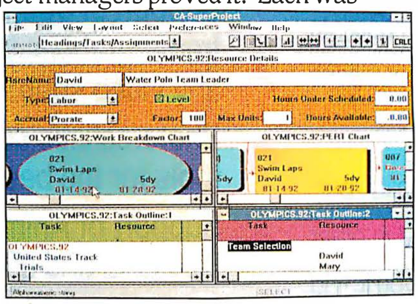


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Drawing Effects	72	13	8	64	10	64	8
Drawing Styles							
Arc	16	N/A	4	N/A	N/A	N/A	N/A
Circle	12	4	8	3	N/A	N/A	4
Curve (Parabola)	8	N/A	1	N/A	N/A	N/A	N/A
Ellipse	8	4	8	3	N/A	8	4
Freehand	3	3	4	2	2	4	3
Irregular Polygon	2	N/A	2	3	N/A	N/A	8
Line	7	7	6	2	4	8	6
Parallelogram	4	N/A	N/A	N/A	N/A	N/A	N/A
Rectangle	12	4	8	3	N/A	8	4
Regular Polygon	24	N/A	N/A	N/A	N/A	N/A	N/A
Spline (Bezier)	2	3	3	N/A	N/A	N/A	3
Square	12	4	8	3	N/A	N/A	4
Load/Display Times							
42K PCX	:03	:39	:11	:36	:05	:13	:05
330K TIFF	:04	:18	:14	:47	:05	:17	:06
289K Uncomp. TGA	:03	N/A	N/A	:45	:05	:16	:07
708K Comp. TGA	:06	N/A	N/A	N/A	N/A	N/A	:17
Image Formats							
!IM	✓	N/A	N/A	N/A	N/A	N/A	N/A
GIF	✓	N/A	N/A	✓	✓	✓	✓
PCX	✓	✓	✓	✓	✓	✓	✓
PTN	✓	N/A	N/A	N/A	N/A	N/A	N/A
TGA	✓	N/A	N/A	uncompressed	uncompressed	✓	✓
TIF	✓	✓	✓	✓	✓	✓	✓
WIN	✓	N/A	N/A	N/A	N/A	N/A	N/A
Hardware							
Batch Printing	✓	✓	✓	N/A	N/A	N/A	N/A
Scanners	✓	N/A	N/A	✓	✓	✓	✓
Video Capture	✓	N/A	N/A	N/A	N/A	N/A	N/A
B/W Printing	✓	✓	✓	✓	✓	✓	✓
Sierra HiColor VGA	✓	✓	✓	✓	✓	✓	✓
Color Models							
CMYK	✓	✓	✓	✓	✓	✓	N/A
RGB	✓	✓	✓	✓	✓	✓	✓
HLS	✓	N/A	✓	✓	✓	N/A	✓
HSV	✓	✓	N/A	✓	✓	✓	N/A
Environments							
DOS	✓	N/A	N/A	N/A	N/A	N/A	N/A
Windows 3.0	✓	✓	✓	✓	✓	✓	✓
Multimedia/Authoring	✓	N/A	N/A	N/A	N/A	N/A	N/A
Audio Support	✓	N/A	N/A	N/A	N/A	N/A	N/A
Suggested List Price	$149 — $495	$695	$695	$695	$795	$495	$495

All tests were performed on an Orchid Technology Privilege 386-33 with 8MB RAM and a Conner 200MB HDD. Windows aplications were tested in 386 enhanced mode with no other tasks running. TEMPRA is a trademark of Mathematica, Inc. All other products are trademarks of their respective owners. TEMPRA speeds clocked before turbo charger feature. Copyright 1991 by Gary A. Klein. All Rights Reserved.

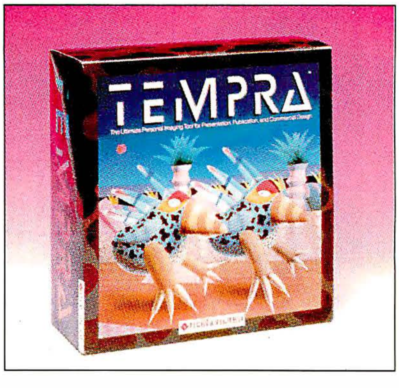
"Mathematica's Tempra 24-bit paint program was another winner, providing unparalled editing speed."
Adam Osborn
NewMedia, November/December 1991

"A top-flight painting/photo retouching program with amazing capabilities. Video speed, even for 24-bit color files, is remarkable. Highly recommended."
Susan Glinert-Stevens
PC Sources, November 1991

"Tempra Pro has some very powerful features. The package's color manipulation and control are hard to beat. Overall, Tempra Pro is an excellent graphics editor that's very easy to use and quite powerful. You will find it possible to create and edit images whether you are a beginner or a professional."
Marc Greenfield
Computer Buying World, November 1991

"Tempra really stands out when working with true-color images. The output from Tempra is excellent. Overall Tempra is a good program. Those who work with full-color images — and any of the supported color scanners — may find it a valuable tool. And the ability to work with video input offers interesting possibilities."
Leonard Hyre
PCM, November 1991

"Tempra gets our nod for PC-based programs. It's the least expensive of the lot and handles a variety of image formats."
Tom Thompson
BYTE Magazine, June 1991



Catalyst Magazine Dream Systems 1991

The Interface Group Best of Spring Award 1991 BYTE Finalist

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1-800-852-MATH

Circle 262 on Inquiry Card (RESELLERS: 263).

A New Unix Standard

BEN SMITH

The HP/Apollo 710 and 705 are small, elegant, inexpensive, and fast systems

Hewlett-Packard/Apollo has introduced two new members to its 9000 Series 700: 710 and 705. These low-priced personal workstations use the PA-RISC processor, the fastest RISC processor being shipped for the workstation market. Although they have a low price, these are not low-end machines: The 710 lists for $9490, but it runs at 50 MHz and yields a BYTE Unix index of 4.6 (see the table), which means that it is more than four times as fast as a comparable Sun Microsystems Sparcstation IPC.



The new HP/Apollo workstations are enclosed in a small, trim case. The CPU can stand on edge (as shown) or sit flat on your desk.

The BYTE Unix index is a suite of tests that evaluate Unix workstation performance on integers, floating-point math, operating system, disk access, and system loading. We have not yet tested the low-end HP/Apollo 705, but we estimate that its index would be approximately 3.5. The 705 runs at 35 MHz and lists for $4990.

Keeping the Packaging Lean

These machines are enclosed in a simple 16¾- by 14¾- by 3-inch case. They include both thick- and thin-wire Ethernet connections, a parallel port, two serial ports, and a SCSI-2 connector. You can save yourself some desk space by setting the CPU case on edge by attaching the feet that are provided. The 710 has an 8-bit frame buffer that provides 256 simultaneous colors to either a 19-inch (1280- by 1024-pixel, 72-Hz) display or a 16-inch (1024- by 768-pixel, 75-Hz) display. A 19-inch gray-scale monitor is also available.

The minimum systems are diskless and come with 16 MB of 80-nanosecond RAM, 32 KB of instruction cache memory, and 64 KB of data cache memory. The RAM can be built up to 64 MB. The maximum internal hard drive storage is 840 MB. The maximum external hard drive is 9.45 gigabytes.

The RISCs of Battle

The high performance of the 9000 Series 700 machines is primarily due to the PA-RISC central processor. The Unix workstation market has turned into a battleground for competing designs. Sun's SPARC design has dominated the workstation market for years, and it will probably continue to do so for many more years because Sun licenses the SPARC design for only a token sum.

IBM's RISC System/6000 brought it from being the most laughable RISC manufacturer (the IBM RT) to one of the most feared (see "Sizzling RISC Systems from IBM," April 1990 BYTE). For at least a year, the RISC System/6000 was the performance leader among workstations. But, despite tens of millions of dollars invested in setting up its marketing and distribution, it still does not dominate the market. With HP/Apollo's introduction of the 720 last year, IBM lost the performance lead as well.

Other notable RISC designs are the Motorola 88000, which doesn't look like it will ever be popular for workstations, and

the Mips processors, which are used in its own machines as well as DEC's RISC workstations and the most recent designs from Sony. The newest Mips processor, the R4000, is a full 64-bit processor and is integral to the Unix plans of the Advanced Computing Environment consortium.

Targeted markets for the 710 and 705 workstations include both the technical and commercial worlds. HP/Apollo has established itself as a valuable source for computer-aided drafting and design workstations. The introduction of the 710 and 705 may well attract members of the commercial world, who need the high resolution and performance for electronic publishing, information management, and group/project-oriented networking.

Already, Lotus 1-2-3, WordPerfect, Wingz, Oracle, Informix, Ingres, Sybase, and the most popular electronic publishing and multimedia packages run on these new machines. When HP/Apollo introduced the 720, there was already a huge repository of software that runs on the PA-RISC minicomputers and the HP-UX operating system. The number and kinds of applications that run on the workstation's design and flavor of Unix are important considerations in evaluating RISC workstations.

BYTE LAB BENCHMARKS

The 710's average score of 4.6 makes it more than four times as fast as a Sun Sparcstation IPC.

Test	Baseline	Result	Index
Arithmetic (type = double)	2541.7	21,255.5	8.4
Dhrystone 2 without register variables	22,366.3	84,850.8	3.8
Excel throughput	16.5	74.2	4.5
File copy (30 seconds)	179.0	1237.0	6.9
Pipe-based context switching	1318.5	1500.4	1.1
Shell scripts (eight concurrent)	4.0	11.0	2.8
Sum of six items			27.5
Average			4.6

Power Shift

HP/Apollo's marketing phrase, "Power Shift," is fitting. With the kind of performance that the 710 offers at the price that it does, the competition is finding itself in a frightening race for the affections of the budget-conscious workstation buyer.

For all but intensive graphics applications, the 710 is more power than a single user needs. It is perfectly feasible and very practical to add an X-terminal to the configuration.

HP/Apollo claims that the 710 can generate 950,000 three-dimensional vectors per second. This is nearly twice the performance of any comparably priced competitor's workstation. Even with 3-D surface rendering, this workstation is no slouch. As with the Iris Indigo, 3-D graphics operations are done without a graphics pipeline coprocessor.

The HP/Apollo 700 line has leapt forward with the software that makes 3-D surface rendering practical on the low-end graphics workstations: the PowerShade libraries and software, which includes Wavefront Technologies' Personal Visualizer. The libraries include operations for all the basic 3-D rendering problems as well as adding haze- and ray-tracing.

If the low end of the 9000 Series 700 doesn't have enough power for your hefty graphics applications, you might consider the 750. It has larger caches and can be expanded to 384 MB of RAM and 2.6 gigabytes of internal hard drive storage. But if all you want is more disk space and another PA-RISC processor, you may need only one of the new low-cost 9000 Series 700 servers.

Choice Computing

I used the 710 as my personal workstation for a month. I did this to become familiar with the machine and also because it gave me the nicest working environment with which to connect to the BYTE network. Yes, the X Window System applications are snappy, but with HP's Vue application and window manager (built on OSF/Motif), my screen's multiwindowed world is also elegant.

Computing is no longer in the Stone Age, and there is no reason why we should be so Spartan as to remain with ugly and difficult computing environments. Add HP's quality and design to the power of Unix computing and its network, and you have a comfortable and productive world in which to work. If you're in the market for a desktop workstation for general use, the 710 and 705 have the best price and performance, without sacrificing quality and good looks. ■

Ben Smith is a BYTE technical editor, a former database consultant, and the author of UNIX Step by Step *(Howard W. Sams, 1990). You can reach him on BIX as "bensmith."*

THE FACTS

HP/Apollo 705 and 710

705 (35 MHz)
19-inch 8-bit gray scale, diskless, $4990
710 (50 MHz)
19-inch 8-bit gray scale, diskless, $9490
16-inch 8-bit color, diskless, $11,490
19-inch 8-bit color, diskless, $13,990

Optional:
210-MB internal hard drive, $2000
420-MB internal hard drive, $2500

Series 700 servers:
720 with 32 MB of RAM, 840-MB hard drive, $23,440
750 with 64 MB of RAM, 1.3-gigabyte hard drive, CD-ROM, 4-mm DAT backup, $57,190

750 CRX-24Z
19-inch 24-bit color, 32 MB of RAM, 1.3-gigabyte internal hard drive, graphics coprocessor, and PowerShade, $63,190

Hewlett-Packard/Apollo
270 Billerica Rd.
Chelmsford, MA 01824
(508) 256-6600
fax: (508) 256-4862
Circle 1219 on Inquiry Card.

Battle of the Heavyweights

MARTIN HELLER

The release of Microsoft C/C++ 7.0 sets up a challenge with Borland C++ 3.0 for the hearts and minds of serious developers

On my left, weighing in at 28 MB on disk and 3200 pages of documentation: Borland C++ 3.0 with Application Frameworks. (Crowd cheers.) On my right, weighing in at 20 MB on disk and 5800 pages of documentation (with a 500-page index): Microsoft C/C++ 7.0. (Crowd cheers again.)

These two contenders come to you compiling C and C++ code. Both target DOS and Windows applications. They each use a DOS Protected Mode Interface server to work in protected mode. Both have DOS integrated environments that work well in a DOS box under enhanced-mode Windows. They each have command-line compilers, linkers, make utilities, debuggers and profilers for DOS and Windows programs, and Windows resource editors. Both have class libraries for building Windows applications, and both have container classes for DOS.

Yet these are different products. Borland includes a Windows integrated environment, a class library for building DOS applications, custom controls for Windows, and an assembler—for $749. Microsoft includes extra compiler and linker options: automatic function in-lining, function packaging, and p-code generation—for $495. (Microsoft sells separately a Windows integrated environment, QuickC for Windows, and Microsoft Macro Assembler.)

Borland C++ 3.0 (BCC) requires 2.5 MB of RAM and a 286 processor to produce Windows applications. Microsoft C/C++ 7.0 (MSC) requires 4 MB of RAM and a 386 processor. The standard developer's machine is probably a 33-MHz 486 with 8 MB of RAM, so Microsoft isn't excluding too much of its real market. If you're still developing with an old AT, you now have an excuse to get a real computer.

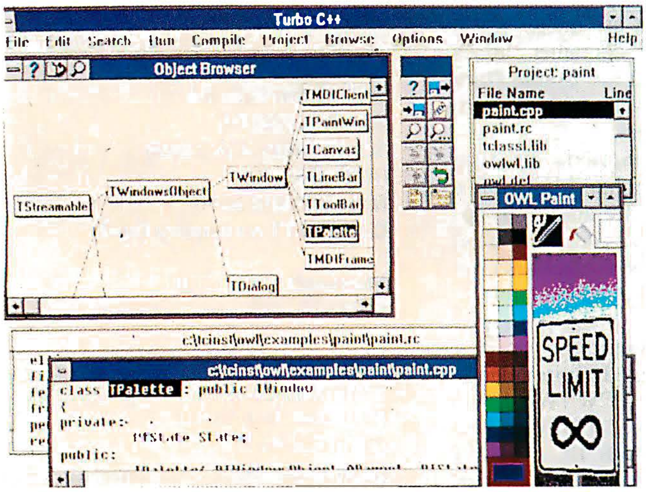
Compiler Performance

For years, BCC had the reputation of compiling quickly to get poorly optimized code; MSC had the reputation of compiling slowly to get well-optimized code. Neither stereotype holds any longer. Both products now compile quickly and produce optimized code. In both cases, you can trade compilation time for generated code quality.

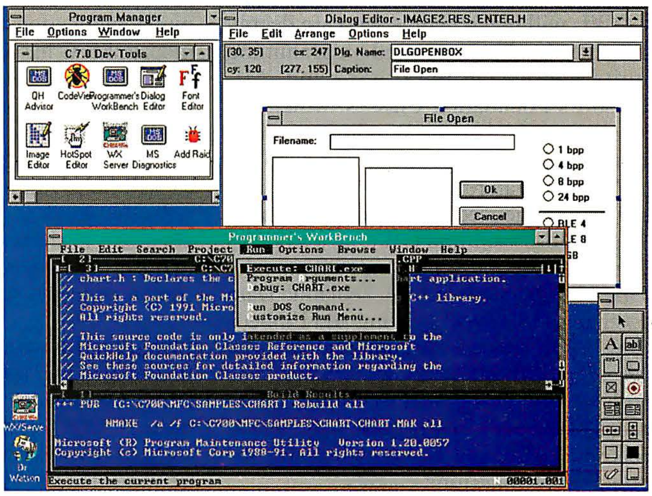
The table shows the preliminary Dhrystone benchmark results. I used a 25-MHz computer with memory and disk caching. Microsoft's new maximum in-lining coupled with global optimization worked magic on the Dhrystone benchmark—a major plus for Microsoft.

The Sieve of Eratosthenes benchmark results I obtained show Borland slightly ahead. There isn't much that can be optimized in the Sieve code. The results in the large model were similar, but not identical, to the results in the small model.

I also timed a complete reconstruction of Image2, a moderate-size Windows application. Clearly, MSC has closed the C compilation speed gap, even when I let



Borland C++ 3.0 with Application Frameworks is fine-tuned for developing Windows applications.



With the release of Microsoft C/C++ 7.0, Microsoft has finally entered the C++ fray.

PRELIMINARY DHRYSTONE RESULTS

The results indicate a major plus for Microsoft.

Compiler	Switches	Run time (seconds)	.EXE size (bytes)	Text size (bytes)
MSC C/C++ 7.0	/Oxaz /Ob2/Gs	3.6	8305	1516
Large model	/Oxaz /Ob2	5.1	14,895	2018
	/Gs /AL/Osae /Gs	7.1	7729	898
Borland C++ 3.0	-O2 -Z -A - ms	6.9	7624	1089
Large model	-O2 -Z -A - ml	8.8	9298	1229
	-O1 -Z -A - ms	8.6	7640	1001

BCC use precompiled headers. When optimizing, the two compilers take the same amount of time and produce code of similar speed, but the MSC executable file is smaller. When quick-compiling, MSC now works faster than BCC. MSC's p-code option produces smaller code than any other option, but it is also much slower code than any other option.

C++ and Class Libraries

MSC has an implementation of C++ 2.1 as described in the *Annotated Reference Manual*, plus experimental exception-handling extensions. BCC has a C++ implementation that mirrors CFRONT 3.0, including template extensions. BCC has additional extensions known as dynamic dispatch virtual tables to support message-response functions in the ObjectWindows Library, Borland's application framework for Windows. Because of these extensions, you can't use OWL with any C++ compiler other than BCC.

OWL will make people who are deeply involved in object-oriented programming quite happy. On the other hand, Microsoft's Foundation Classes, which basically encapsulate the Windows application programming interface and keep the API nomenclature, make it relatively easy for an experienced Windows program to migrate to C++. I find OWL nice as far as it goes, but it doesn't cover, for example, Graphics Device Interface, Dynamic Data Exchange, or Object Linking and Embedding. MFC, while it constitutes a very thin layer on top of the Windows API that does little abstraction in and of itself, covers most of the API in a regular way, and it lets you easily add functionality and abstraction by inheriting classes.

MFC seems to have less overhead than OWL. Consider the size of a "Hello, World" application. HELLOAPP.EXE built with MFC is 14,901 bytes long; HELLOAPP.EXE built with OWL is 114,693 bytes long. No, I didn't make a mistake: A minimum OWL application is over 100 KB on disk, because pretty much the whole library links in. Microsoft, on the other hand, was able to make its MFC classes more granular and to let its linker exclude unreferenced packaged functions. Packaged functions include, by default, all C++ member functions. The big gain here is excluding unnecessary member functions from the executable image.

This isn't as bad as it seems, because not all that baggage gets into memory. The RAM footprint of the MFC HELLOAPP is 18 KB; the RAM footprint of the OWL HELLOAPP is 28 KB. I'd like to see Borland enhance its compiler and linker to reduce the .EXE file size.

Microsoft has no equivalent to Borland's Turbo Vision application framework for DOS, which offers a lot of capability and makes it easy to build DOS character-mode applications that use menus and a mouse. MFC has some container classes and utility classes that are usable from DOS, but the major thrust of MFC is to aid Windows developers.

If you're targeting DOS, Borland's classes will help you more than Microsoft's will. But don't expect TV and OWL applications to share source code: While the two Borland application frameworks use similar concepts, they're incompatible.

Integrated Environments

BCC offers two integrated environments: BC (DOS-hosted) and TCW (Windows-hosted). MSC offers one DOS-hosted integrated environment, PWB. BC and PWB let you get at the full functionality of their compilers; TCW doesn't. TCW and PWB have browsers; BC doesn't. I like working completely within Windows, which leads me to favor TCW. But it's frustrating that I can't do maximum optimization from TCW. PWB (which is much improved from previous incarnations) at least lets me do everything from one place—including launching Windows applications from a DOS box, thanks to some new technology—but I wish Microsoft had done a real Windows-hosted environment.

Borland's Resource Workshop is a fine tool for Windows developers that is similar to Mac ResEdit. MSC now comes with the basic set of resource-editing tools from the Windows Software Development Kit. Borland's TDW debugger now supports hardware breakpoints; Microsoft's CVW has speed and size improvements, and it fully supports C++ and p-code. Borland's WinSight is a neat message-monitoring utility. Microsoft Link can now build huge overlaid DOS programs.

I could go on at length discussing other new features; both packages have many. The bottom line is that both MSC 7.0 and BCC 3.0 well serve the needs of professional Windows and DOS applications developers who work in C or C++. There was no knockout; the fight has to be scored on points, and you're the judge. ■

Martin Heller develops software and writes about computers. He can be reached on BIX as "mheller."

THE FACTS

Borland C++ 3.0 with Application Frameworks
$749

Borland International, Inc.
1800 Green Hills Rd.
P.O. Box 660001
Scotts Valley, CA 95066
(408) 438-8400
fax: (408) 438-8696
Circle 1211 on Inquiry Card.

Microsoft C/C++ 7.0
$495

Microsoft Corp.
1 Microsoft Way
Redmond, WA 98502
(800) 426-9400
(206) 882-8080
fax: (206) 883-8101
Circle 1212 on Inquiry Card.



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5 times their size–for prices that are less than most other notebooks. There's a full range of high-performance, low-cost models to choose from.

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NEWS

FIRST IMPRESSIONS

Dell Delivers Color Computing Without a Price Penalty



It seems like manufacturers have been showing portable computers with color screens at trade shows for years. In fact, they have, starting with those so-called technology demonstrations a very long time ago. Some color portables have been available, but at eyebrow-raising and wallet-clearing prices that hovered around the five-figure area. No, thank you.

The major problem has been the availability of color flat-panel displays. Finally, color LCD screens that can run off battery power are becoming available in quantity, and that means that those long-awaited color notebook computers will soon appear.

After months of promises from a number of major players, the first color notebook I've been able to keep for a while and test arrived on my desk at the very end of 1991. The Dell System 325NC shows just how quickly you can get used to having color in your briefcase. What's surprising is the bottom line. Dell has brought a full-power color notebook to market for not much more than a comparably equipped unit with a monochrome screen: $3999.

The 325NC weighs in at a respectable 7 pounds and measures 8½ by 11 by 2⅓ inches. That's a little heavier and a bit thicker than your garden-variety monochrome notebook, but this is one loaded notebook computer. It's based on Intel's 25-MHz 386SL (low-power) processor, but more about that later.

The display on the 325NC is a 9½-inch diagonal passive-matrix triple-supertwist nematic LCD that displays 16 colors in standard VGA (640- by 480-pixel) resolution. It can also display 256 colors, although in CGA (320- by 200-pixel) resolution.

Active-matrix displays are considerably brighter than passive-matrix displays. Active-matrix displays also use much more power and are more expensive.

I'd never worked with a passive-matrix display before, and I was at first a bit disappointed. The image isn't as bright as I'd like it, and the colors are on the muted side. But this isn't, after all, a desktop VGA display. It didn't take long for me to get used to it, and the more I used it, the more I liked it. I soon realized how important the color factor is with the applications that I use regularly—especially in Windows.

Of course, a color display deserves a high-powered and high-quality system to go along with it, and the rest of the 325NC is no slouch. It's obviously designed from the ground up as a cohesive whole. Dell has come a long way from its roots as a purveyor of me-too clones.

Today's notebook computers are designed to use battery power conservatively. The 25-MHz 386SL that's the heart of the 325NC is state of the art for today's notebooks. It's crammed with power-saving features, including sleep and suspend/resume modes. Dell has added more: custom firmware and a custom application-specific IC whose entire purpose is power management.

The 325NC has yet another state-of-the-art feature: A nickel-metal-hydride battery lasts longer and doesn't have the "memory effect" that nickel-cadmium batteries are infamous for (i.e., delivering less power the more times they're recharged).

The end result of all this engineering is a system that will run for an average of about 3 hours on a charge. Some notebooks with monochrome displays don't do as well.

As far as other system features are concerned, the 325NC comes standard with 4 MB of RAM (expandable to 12 MB), a 60- or 80-MB hard drive, a 3½-inch 1.44-MB floppy drive, and the usual assortment of ports, including PS/2 mouse and keyboard connectors. Options include a 2400-bps modem and a 9600-bps data/fax modem.

The 85-key keyboard has a solid big-system feel. Its layout is becoming standard for today's crop of notebooks. Because a pointing device of some sort is a necessity in today's Windows-centric world, the 325NC comes standard with the Microsoft Ballpoint mouse, which is actually a miniature trackball. It's not the smallest pointing device that's available for portable computers, but I have found it to be one of the best. I use one with the notebook computer that I own.

On the performance front, the 325NC is impressive. I ran the BYTE Lab benchmarks and found that the 325NC compared favorably with others in its class. This is a machine that's comfortable for even computation-heavy applications, especially if you pop in the optional 387SX math coprocessor.

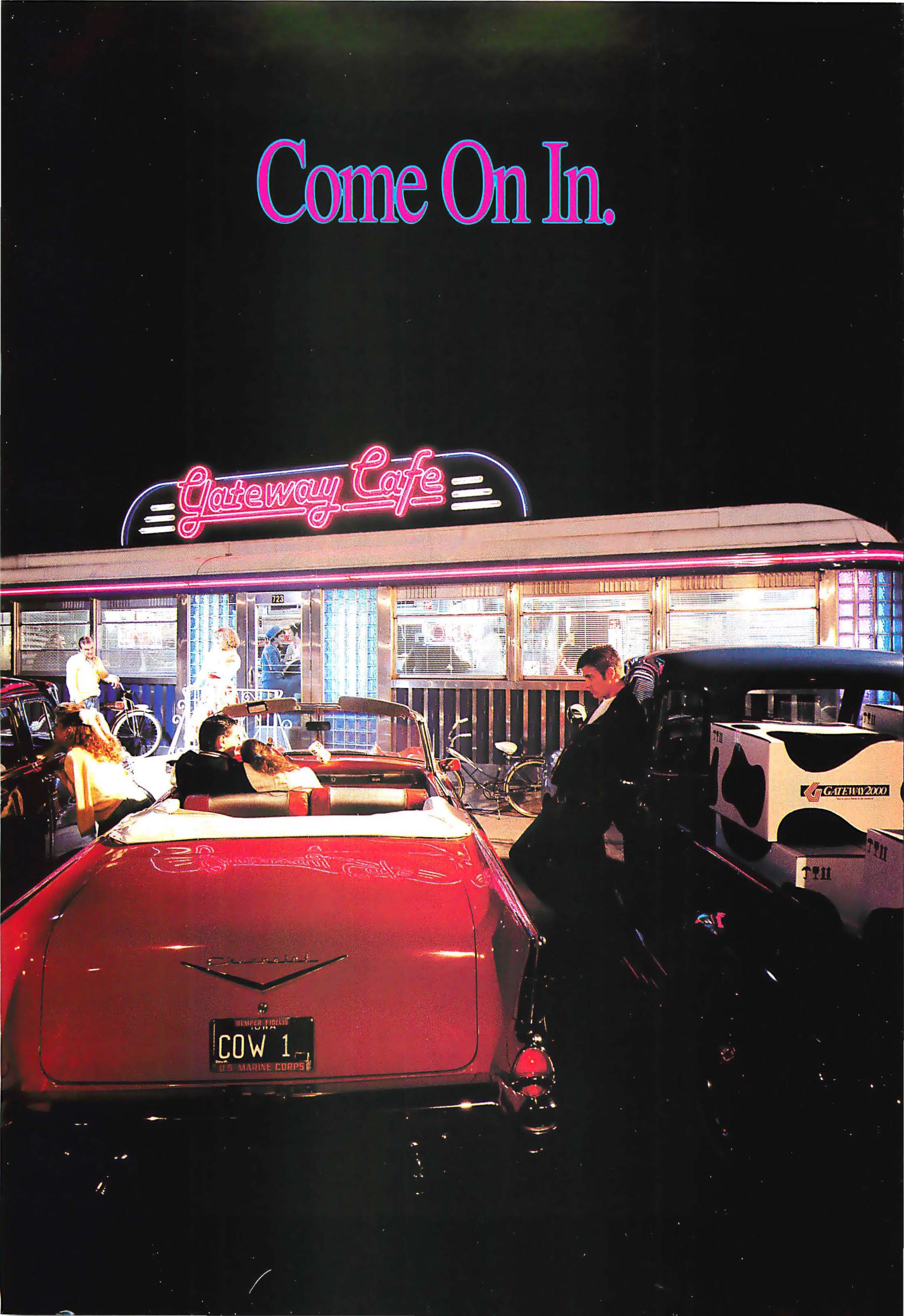
Dell's aggressive pricing strategy will give the demand for color notebooks a much-needed kick in the pants and will make competitors very nervous, especially those known for premium prices. With its $3999 price tag, the question of whether you need a color notebook almost becomes moot. Color adds a new dimension to portable computing, and when you can get it for virtually the same price as a comparable monochrome unit, what are you waiting for?

—Stan Miastkowski

THE FACTS

Dell System 325NC
$3999; with 80-MB hard drive, $4299

Dell Computer Corp.
9505 Arboretum Blvd.
Austin, TX 78759
(800) 426-5150
(512) 338-4400
fax: (512) 343-3312
Circle 1213 on Inquiry Card.


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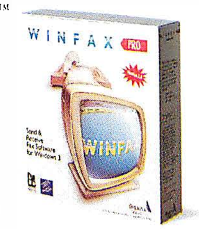
When you buy a personal computer from Gateway 2000, the experience has its similarities. You get a solid quality, high-performance computer that comes fully loaded with all the

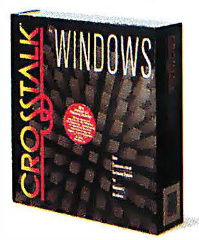
Gateway Cafe

Specials | **Side Orders**

Introducing The Gateway TelePath

For $195, you get the Gateway TelePath – a new custom-designed V.32bis modem with full fax capability plus WinFax Pro,™ Crosstalk® for Windows™ and a free trial membership with CompuServe®. Anywhere else you'd pay more for the software alone!





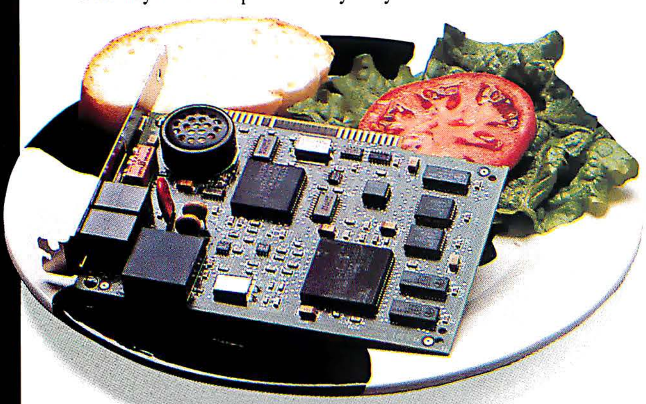
Gateway 2000's engineers designed this internal modem and fax card to incorporate everything our customers were hungry for in the arena of PC communications.

Speed. The Gateway TelePath modem operates up to 14,400 bps. The Gateway TelePath send/receive fax runs at 9,600 bps.

Compatibility. The 14,400 bps modem is compatible with the standard AT command set and can be used with almost any compatible software. With the Gateway TelePath fax, you can send to or receive from any Group 3 or earlier fax machine using Class 1 or Class 2 commands.

- Fax mode: V.17, V.29, and V.27ter
- Data mode: (try to find one we don't support!) V.32bis, V.32, V.22bis, V.22, V.21, Bell 212A and 103, V.42 and MNP 2-4 error correction, V.42bis/MNP 5 data compression

Price. You'll find comparable fax/modem packages can cost in excess of $500 not including the software. At $195, the Gateway TelePath price is very easy to swallow.



New Video Options For Your PC

The 15-Inch Crystal Scan 1572FS

It's bigger, but that's just one of the improvements we've made to the 15-inch Crystal Scan 1572FS. The new flat, square, non-glare screen reduces distortion around the corners and provides an edge-to-edge display area. The refresh rate is higher, 72 Hz, for added image stability and flicker-free display. Dot pitch is 0.28mm. We've also moved the fine tuning controls to the front of the monitor for easy access.

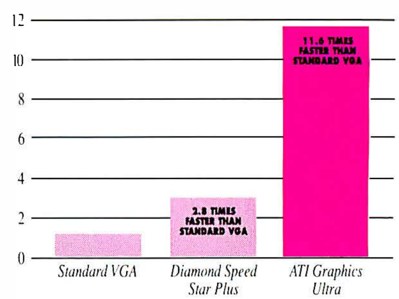


The Crystal Scan 1572FS is an option with 386DX and 486 systems for an additional $195. Availability is limited.

The ATI® Graphics Accelerator

You're really cookin' when you run a Gateway 2000 system with ATI's graphics accelerator, the Graphics Ultra. ATI achieves a quantum leap in performance by using a highly optimized graphics coprocessor on the Graphics Ultra card. The 1024 x 768 mode is fully compatible with IBM® 8514, VGA, Super VGA and previous IBM graphics standards, which makes it easy to install applications using the standard video drivers.

The ATI Graphics Ultra video card is standard with the 486-33 system, optional with 386DX and 486 systems. The street price of this card is over $500, but with the purchase of a Gateway 2000 system, you can upgrade to it for $150!



Figures computed on a 486/33 and provided by ATI Technologies Inc.

Peripherals are sold only with the purchase of a system. If you already own a Gateway 2000 computer, you can buy peripherals separately.

Gateway Cafe

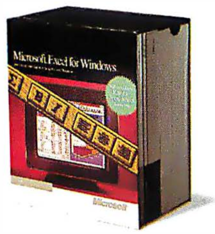
Desserts

Desserts

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With the purchase of any Gateway 2000 386SX, 386DX or 486 computer system, you now receive your choice of free application software. Pick one from the seven application options in our software buffet. We'll install one software option on your hard drive, optimally configured for your system and Windows, and provide you with the master diskettes and manuals – absolutely free.

You can also buy additional software at extremely competitive prices, or choose from other popular applications not listed here. Ask your sales person for the details.

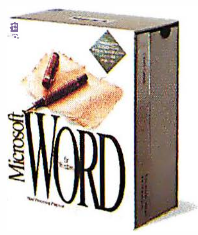


Option #1

Microsoft® Excel for Windows™ 3.0

- A powerful graphical spreadsheet program
- Includes online help for Lotus® 1-2-3® users
- *PC Magazine's* Editor's Choice

Retail value: $495. Discount value: $300+. Can be yours free with a Gateway 2000 PC!



Option #2

Microsoft Word for Windows™ 2.0

- Best selling word processor for Windows
- New version 2.0 adds spectacular refinements
- Includes online help for WordPerfect® users

Retail value: $495. Discount value: $300+. Can be yours free with a Gateway 2000 PC!



Option #3

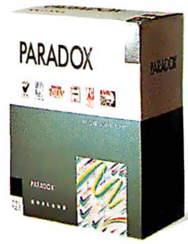
Microsoft PowerPoint for Windows™ 2.0

- Easy-to-use desktop presentations program
- Creates high-quality overheads and 35mm slides

Retail value: $495. Discount value: $300+. Can be yours free with a Gateway 2000 PC!

Option #4

The Paradox® 3.5

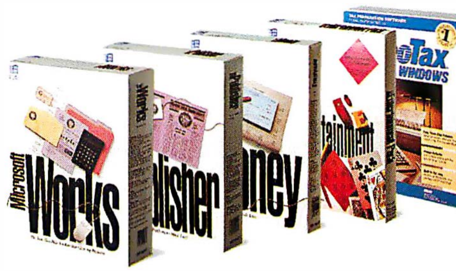


- Award-winning database management program
- From Borland®, the leader in database and programming software

Retail value: $695. Discount value: $500+. Can be yours free with a Gateway 2000 PC!

Option #5

The Entrepreneur Pack



Includes Microsoft's Works,™ Publisher™ and Money,™ the latest versions, and an Entertainment Pack, all for Windows, plus TurboTax for Windows® from ChipSoft

- Works integrates a word processor, spreadsheet, database and more into one easy-to-use program
- Publisher has page layout tools to create publications
- Money helps you control your finances by writing checks, setting budgets, tracking expenses
- Entertainment Pack, eight games including Tetris®
- TurboTax is an easy-to-use tax preparation program with online help for understanding IRS rules

Retail value: $607. Discount value: $400+. Can be yours free with a Gateway 2000 PC!



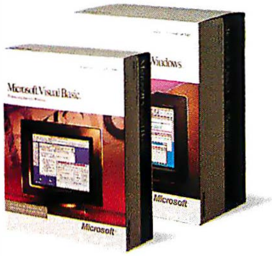
Gateway Cafe

Desserts

Main Course

There's A PC Here That's Just What You're

Option #6
The Windows Programmer Pack



Includes Microsoft's QuickC for Windows,™ Visual Basic for Windows,™ Windows Control Development Kit,™ MS Windows Help Compiler™ and MS Windows Programmer's Online Reference™

- Everything you need to create programs for Windows

You can't buy all of these tools in one package elsewhere, but this option can be yours free with a Gateway 2000 PC!

Option #7
Microsoft Project for Windows™ 3.0



- Flexible and easy project management program
- Includes interactive online tutorial
- *PC Magazine* calls it the best program in its category

Retail value: $695. Discount value: $425+. Can be yours free with a Gateway 2000 PC!

If the free software packages offered here don't suit your needs, we have others that are very competitively priced. For example, if you'd rather get Microsoft Office,™ which includes Word for Windows, Excel and PowerPoint, you can upgrade to it. Office retails for $750, with a discount value of $499. It can be yours for only $175 with a Gateway 2000 PC. Ask your sales representative for details.

This offer includes the identical applications contained in retail packages but will not include the retail box. You get a complete set of diskettes and manuals, shrink-wrapped and packaged in a Gateway 2000 box.



Gateway 2000 computer systems – the meat and potatoes of our menu – come with all the trimmings at no extra charge. All systems have plenty of RAM, two diskette drives, fast and reliable hard drives, 16-bit VGA graphics, color monitors and the 124-key programmable AnyKey™ keyboard. We use only the highest quality components in our systems. Every model includes MS DOS 5.0, and 386SX, 386DX and 486 models come with Windows 3.0 and a Microsoft mouse.

Substitutions are welcome! We custom build each Gateway 2000 system to your specifications.

286 And 386SX Systems

Gateway 2000's 286 and 386SX systems come in a compact, mini desktop model. To give you plenty of room for expansion in a small footprint system, we integrated the diskette drive controller, the video chip set and the I/O card on the motherboard, leaving five 16-bit slots open in the standard configuration.



The mini desktop models have a standard mouse port (PS/2 compatible), leaving two serial ports open. RAM on these systems is expandable to 16MB on the motherboard. The Western Digital® IDE hard drives feature a 32K read-look-ahead cache buffer. All mini desktop models have Quadtel® BIOS and 200 watt power supplies.



The 124-key AnyKey keyboard comes standard with all Gateway 2000 systems.

Gateway Cafe

Main Course **Main Course**

Hungry For

386DX Systems

The 386 systems have a true 32-bit memory bus and more expansion capability. We start with a genuine Intel® 80386 microprocessor on a Micronics® motherboard. We add a generous portion of RAM – 4MB expandable to a system total of 64MB. Put in 64K of cache RAM on the 386/33 for a nice performance boost. Add IDE hard drives from Western Digital. Then give them Diamond Speedstar Plus™ 16-bit VGA graphics cards with 1MB RAM, non-interlaced 14-inch Crystal Scan 1024 x 768 color monitors, Phoenix™ BIOS, a Weitek socket on the 33 and 200 watt power supplies. That's the basic recipe for these tried-and-true, workhorse computers.



Both systems have a 32-bit slot open in the standard configuration for RAM expansion. The motherboard has a total of one 32-bit and seven 16-bit slots, with one 32-bit and five 16-bit expansion slots available in the advertised configuration. Gateway's 386DX and 486 systems come in a desktop model that is roomy and easily accessible. A floor-standing tower model is an option for an additional $100.



486 Systems

Gateway 2000's 486 systems run on the real McCoy – an Intel 80486 processor with built-in math coprocessor and 8K instruction cache. The 486/33 has a Micronics® motherboard, while the motherboard for the EISA system is custom -manufactured for Gateway 2000. RAM is expandable to a system total of 64MB. Both systems also have an external cache to further increase performance: the ISA system includes 64K; the EISA PC has 128K.

New on the 486/33 is the ATI® Graphics Ultra, which is the fastest video card by far in its class. The EISA model includes a Diamond Speedstar Plus, which is also a high-performance video card. Both systems come with 1MB video RAM.

The 486/33 has eight 16-bit slots on the motherboard, six available in the standard configuration. The EISA machine has eight 32-bit EISA slots on the system board. You have five 32-bit EISA slots open in our standard configuration.

The 486/33 has Phoenix BIOS, while the 486/33 EISA uses Award® BIOS. Both systems come with Weitek sockets and 200 watt power supplies.

Please refer to the back page of this ad for system configurations and prices.





NEWS

FIRST IMPRESSIONS

Twiddling at My Computer

The first time I saw the **Twiddler**, I was enchanted. An alternative input device that is both keyboard and mouse, the Twiddler fit my hand comfortably, secured by the adjustable Velcro and nylon strap.

Ergonomically designed for right- or left-handed use, the 5-inch-long Twiddler is equipped with a 6-foot cord and is capable of working as far as 50 feet away from laptop and desktop computers with an extension cable, a definite advantage when giving presentations.

The Twiddler has three rows of miniature oval keys on the front surface. Each row is designated by a color: red signifying the left row, blue the middle row, and green the right row. An oval pattern of small round buttons on the top back curve of the Twiddler provides thumb control of Alt, Control, Shift, function, and number keys, as well as control of the unit's mouse capabilities.

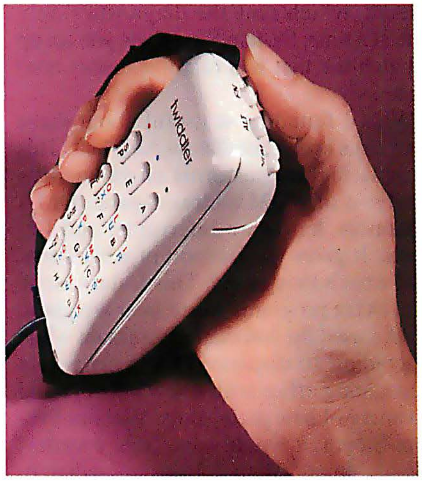
The 12 finger keys on the front of the unit emulate a 101-key keyboard via chord keying. You press and release one or more keys at a time, with each combination generating a unique character or command. You can create your own key chords for words and groups of words that you use frequently.

The mouse pointer in the Twiddler is based on an electrolytic tilt sensor that is sealed inside the device. By pressing the mouse button on the top of the unit and pointing with your index finger in the direction you want the device to tilt, you control the cursor on the screen.

The people at Handykey promise that most of us can learn the alphabet on the Twiddler in about 3 minutes and will master the device in about 10 days. I was doubtful that I would be able to claim such victories. But sure enough, when I started to use the device, I quickly found myself remembering not only the alphabet, but also the preprogrammed macros. By the third time I picked up the Twiddler, my finger memory was beginning to kick in, and I was automatically able to press the proper chords for letters and words that require key combinations.

Each time I used the Twiddler, I noticed a bit more control over my hand, so I was able to type faster and more accurately. Twiddling my way through my work is an appealing alternative.

—Carol J. Swartz



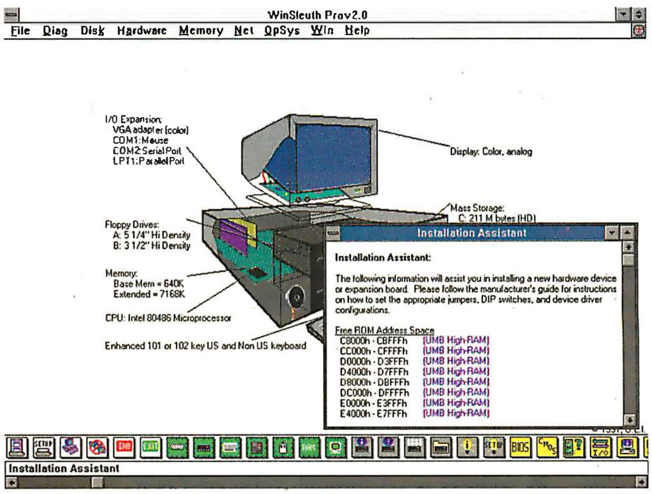
THE FACTS

Twiddler
$199

System requirements:
DOS 3.1 or higher, Windows 3.0 or higher; keyboard and serial ports.

Handykey Corp.
141 Mount Sinai Ave.
Mount Sinai, NY 11766
(800) 638-2352
(516) 474-4405
fax: (516) 474-3760
Circle 1214 on Inquiry Card.

New Sleuths Delve Deep



Let's face it: A "standard" PC simply doesn't exist. Take here at BYTE, for example. Besides a few standard add-ins, each editor has a custom-configured system, with parts and pieces from a variety of manufacturers. Diagnosing pesky problems or installing peripherals and add-ins in this bewildering hodgepodge can be a nightmare.

Diagnostic utilities are designed to help. Several products are available, each updated on a regular basis to keep up with the march of technology. In the past, we've given Dariana's System Sleuth a so-so rating. But the release of **System Sleuth Professional 4.0** and **WinSleuth Professional 2.0** has changed my opinion. These products—one for plain-vanilla DOS and one for Windows—are cutting-edge utilities that ferret out even the most annoying intermittent problems.

The latest incarnations of System Sleuth and WinSleuth are fully redesigned and expanded from their prior versions. Both are similar in their abilities. They're designed to diagnose problems and help with installations. There are, however, some intriguing differences. WinSleuth has all the abilities of System Sleuth, but because it is a Windows utility, it's graphics-oriented. Also, because of the underlying technical complexity of the Windows environment (and the probability of more esoteric things going wrong), it has many more features. There's a bewildering array of icons, whose features are thankfully available on those ubiquitous pull-down menus.

I simply don't have the room to cover all the features of WinSleuth. What I found

particularly interesting was a "tune-up" option that made specific recommendations on how to change my WIN.INI and SYSTEM.INI files for maximum performance. And no other diagnostic program offers the wealth of Windows-specific information that WinSleuth does. You can look at the details of Windows memory management, descriptor tables, and even lists of exception handlers and Windows tasks.

System Sleuth, the plain-vanilla DOS version, offers a wealth of similar features (sans the Windows-specific ones of WinSleuth). It shows you virtually everything that you'd ever want to know (and more) about your system. There's excruciating detail about disks, memory, adapters, and hardware. It's all wrapped up in a new and easier-to-use interface with drop-down menus.

Both versions of the program offer exhaustive diagnostics for all system components, from the hard drive to RAM. This is one area where the non-Windows version has a distinct advantage. Unlike WinSleuth, which runs the diagnostics only one at a time, System Sleuth lets you set up a batch file that will run diagnostics continuously.

What I found most useful about these programs is the Installation Assistant. This unique feature performs an exhaustive analysis of ROM address space, DMA channels, hardware interrupts, and I/O ports. It gives you a report of what's free and what's being used. This feature alone makes the programs worth their weight in gold. I used the Installation Assistant while upgrading 10 disparate PCs in my wife's accounting office with a new network and a variety of new peripherals. Without System Sleuth, it would have been a veritable nightmare. With it, I was immediately able to set jumpers on add-in boards.

Either System Sleuth Professional 4.0 or WinSleuth Professional 2.0 is one of the few programs that I consider absolutely and positively necessary on my PC. One of them should be on yours, too.

—Stan Miastkowski

THE FACTS

System Sleuth Professional 4.0
WinSleuth Professional 2.0
$169 each

System requirements:
System Sleuth Professional: IBM PC, AT, PS/2, or compatible.
WinSleuth Professional: Any system running Windows 3.0 or 3.1.

Dariana, Inc.
7439 La Palma Ave., Suite 278
Buena Park, CA 90620
(714) 562-5777
fax: (714) 994-7401
Circle 1215 on Inquiry Card.

Truevision's Bravado

Truevision, one of the veterans of the computer video gear business, has thrown its hat into a new ring: video in a window/video overlay. Truevision's **Bravado** board takes in video from an external source (e.g., a camcorder, VCR, or laser disc player) and shows that video in a window on a computer display. The video can also be overlaid with computer-generated graphics. Boards in this class are frequently used for interactive multimedia applications, but they have other uses as well, ranging from video editing to stock market watching.



I brought a prerelease Bravado board into BYTE's Multimedia Lab for a spin. Bravado combines, on a single full-length board, all the features I can imagine wanting in a video-in-a-window product. And, true to Truevision's style, Bravado does more than it has to. It incorporates a full-featured VGA adapter (based on the Tseng Laboratories ET4000 chip set), eliminating the problem of interfacing to existing VGA cards, simplifying installation, and freeing up a slot in the bargain.

Bravado's other twist is that you can cascade multiple Bravado boards to provide access to multiple video sources. On the video-in-a-window side, Bravado does its duty: real-time video in a scalable window, with accompanying audio. It can handle NTSC or PAL signals, and it can save and load "frozen" video and other images to and from disk.

The board is simple to install. One DIP switch sets its port address. A RAM buffer is used to process the real-time video, but its address is set through software (as it should be). Once the board is installed, you simply plug your VGA or Super VGA monitor into the standard 15-pin connector and route your incoming video and stereo or mono audio through a sturdy cable set that attaches to a 25-pin external connector. The cable set includes a headphone jack. Bravado's on-board amplifier will drive a pair of headphones or small speakers. Internally, Bravado is equipped with a VGA feature connector, a cascade connector, and fittings for an alluded-to compression board, which is not yet available.

I tested Bravado with a prerelease set of software drivers and applications. Bravado's software is built to run under Windows 3.0. Even at the prerelease stage, the entire installation

THE FACTS

Bravado
with 8-bit VGA, $1295; with 16-bit VGA and options, $1495

Truevision, Inc.
7340 Shadeland Station
Indianapolis, IN 46256
(317) 841-0332
fax: (317) 576-7700
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For the exciting world of multimedia, you need more storage space, faster access and more peripherals, but your computer has limited expansion slots. The high performance solution is CorelSCSI which provides the fastest universal interface (up to 10MB / sec.) for up to seven peripherals using a single card!

No additional software is needed because CorelSCSI supports hundreds of devices.

And CorelSCSI is multi-platform, with support for DOS, OS/2, Windows and Novell NetWare.

Available in 16 bit, 8 bit, and MCA versions.

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process was automated, and a thorough testing program was included. The Windows drivers set the on-board VGA to run at resolutions of 640 by 400 pixels, 640 by 480 pixels, or 800 by 600 pixels in 256 colors. The 1024- by 768-pixel mode supports 16 colors only (the VGA component is equipped with 512 KB of memory). It's worth noting that the 256-color display modes are compatible with the Multimedia Extensions for Windows.

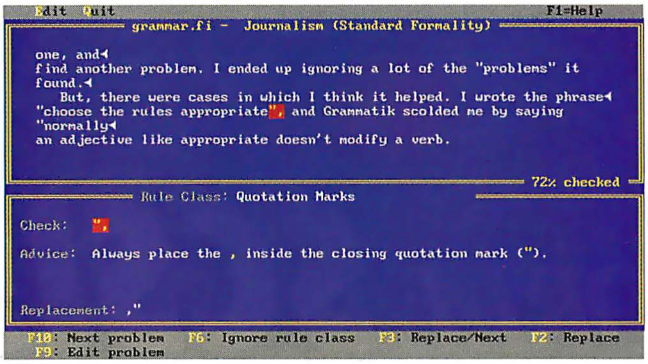
The lone Windows application, Bravado Control, wasn't quite complete, but it gave me a good feel for what the board can do. The application consists mostly of a real-time video window that can be changed to any size and a set of menus that lets you fiddle with various video and audio adjustments. The program also includes a simple "remote-control" dialog box that has the ability to control a small assortment of video devices through the PC's serial ports.

While the software wasn't quite finished, the Bravado board itself proved quite robust. It put up sharp, stable video and crisp true-color still images. When this board hits the streets, the key to its success will be the quality of its supporting software. Having chosen Windows, Truevision is duty-bound to provide a Media Control Interface driver for applications to hook into. That's yet to come, but after my first brush with Bravado, I came away impressed.

—*Tom Yager*

A New Generation of Grammar-Checking Technology

While Grammatik has always been an interesting product and a leader in the field of grammar checkers, **Grammatik V for DOS** is a significant upgrade.



With this new version, Reference Software introduces the industry's first paragraph-level checking that tells you when you've used the same word too often. Another unique feature is access to 10 customized writing styles, each with three levels of formality.

Grammatik V uses a new parsing engine to analyze sentences. The engine is integrated with the first root-based dictionary and spelling checker. The dictionary and parsing engine use 96 grammatical attributes (e.g., parts of speech) to analyze sentences—more than twice the number used by Grammatik IV. Sixty rule classes of grammar, according to Reference Software, add thousands of rules that help identify complex writing problems, such as subject and verb or pronoun agreement errors. Version V also suggests replacements for many more grammatical errors.

The program works with 25 word processors and is hot-key-accessible within WordPerfect, WordStar, Microsoft Word, Professional Write, PFS:First Choice, and XyWrite III Plus.

When running Grammatik in interactive mode, it pauses at each writing problem and awaits your response. It displays the current writing problem highlighted in the paragraph, displays the rule class for the writing problem, offers advice for correcting the problem, suggests a replacement word or phrase, and gives you optional commands for responding. The easiest way to correct an error is by choosing the Replacement command. By pressing the F2 key when you see Replacement in the advice window, Grammatik replaces the highlighted error with its suggested replacement.

Grammatik also has a Learn Word command. This puts a word into its spelling dictionary. I always have a hard time checking spelling in technical material because the spelling checker doesn't "know" what I think are common acronyms and abbreviations. So the only useful spelling checker is one that, like Grammatik V, can be taught.

Another problem I've had with spelling and grammar checkers is that they always think they know best. In some cases, I think the rules of writing should be a bit more flexible. Grammatik V addresses this as well, by letting you ignore the rules or corrections it throws at you.

All the added features in Grammatik V are well and good, but the beta copy I tested wasn't as proficient as I would have liked. In one case, it read my use of *it's* incorrectly and told me to use *its*. I'm glad that I knew better. In a few other instances, it actually went backward to find problems. It would identify a problem at the end of a sentence, jump to the beginning of that sentence or a previous one, and find another problem. I ended up ignoring many of the "problems" it found. But there were cases in which I think it helped.

What I like best about the program are the statistics. It rated this First Impression a 54 in the Flesch Reading Ease. That's "fairly difficult" to read and indicates about a tenth-grade reading level. It also gave me a Fog Index of 13, indicating the approximate grade level a reader must have achieved to understand this First Impression.

In conclusion, assuming the problems I encountered will be resolved by the time the software is released, Grammatik V could be must-have software for every person who writes. It did clean up my typos and helped with some grammatical construction. I find all that worth $99. ■

—*Anne Fischer Lent*

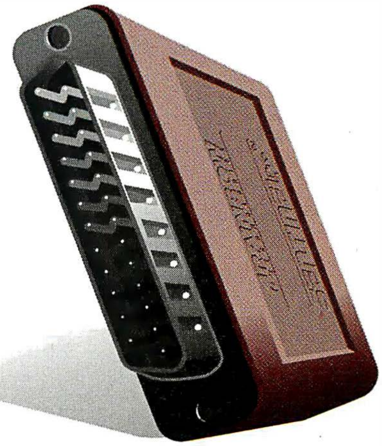
THE FACTS

Grammatik V for DOS
$99

System requirements:
IBM AT or compatible with DOS 3.0 or higher, 640 KB of RAM, and a hard drive.

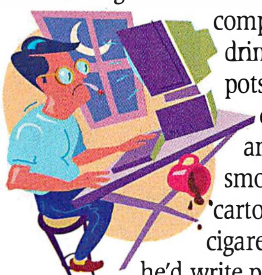
Reference Software International
330 Townsend St., Suite 119
San Francisco, CA 94107
(800) 872-9933
(415) 541-0222
fax: (415) 541-0509
Circle 1218 on Inquiry Card.

Why do they call it a dongle?



He wasn't famous. He didn't drive a fancy car, but dressed in his favorite Comdex T-shirt and faded blue jeans, he set out to change the course of the computer software industry. Quite a task for a lonely software developer.

Sitting in front of his computer, drinking pots of coffee and smoking cartons of cigarettes, he'd write pages of code.



It took time. Years in fact. But he did it. He wrote the most powerful computer program in the world. Now came the hard part. Selling it.

The Most Powerful Program in the World

Determined to make those long years pay off, he called on every distributor, VAR and dealer in the world. He drove from Beantown to San Diego. Flew from Dublin to Borneo. Everyone loved the program.

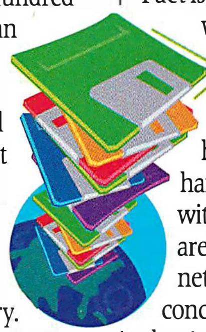
So he sold a few. Only a few.

Back in Boston he waited. After a long year with only 13 orders he set out to see what happened. As he drove across the country and flew around the world he discovered everyone knew about his program. Everyone had it too.



The Global Marketplace

From Paris to Prague, his program was everywhere in Europe. When he got off the plane in Hong Kong he found his program stacked to the ceiling in every computer store. Amazed in disbelief, he bought a hundred cartons of cigarettes and a hundred pounds of Indonesian coffee and flew back to Boston.



Beaten, battered and bruised he went back to the drawing board. This time he would really change the face of the software industry. He would develop a device that would prevent unauthorized distribution of software programs.

Call It What You Like

He developed a hardware key. His peers applauded his efforts. Finally, a solid solution for revenue protection.

But he didn't know what to call it. He thought of naming it after an exotic place he visited in his travels. Madagascar was a bit too long, though.

"Name it after you, Don!", urged his peers. So he did. Soon everyone was calling the key a dongle, after Don Gall— the lonely software developer who did what he had to do.



You've Come A Long Way, Baby

Today, dongles are different. Fact is, they've come a long way. Leading the industry with security solutions, Rainbow Technologies has changed the face of hardware keys. They work with multiple applications, are programmable and network versions control concurrent usage. And they're always transparent to the end-user.

Sentinel Family from Rainbow

Truth is, more and more developers are using keys. And the Sentinel Family is the most widely used in the world. In fact, over 6,000 developers use Sentinel from Rainbow. Why? They are simply the most effective, reliable and easy to implement keys on the market.

Learn more about securing your software and how keys provide developers with extra value. Call for a free copy of **"The Sentinel Guide to Securing Software."** And see just how easy it is to install a hardware key into your application in just minutes. Try it with our low cost Sentinel Evaluation Kit. Order one for your DOS, OS/2, Windows, Macintosh or UNIX based application.



And remember, when you need a dongle, you need Sentinel — the only dongle Don Gall would use.

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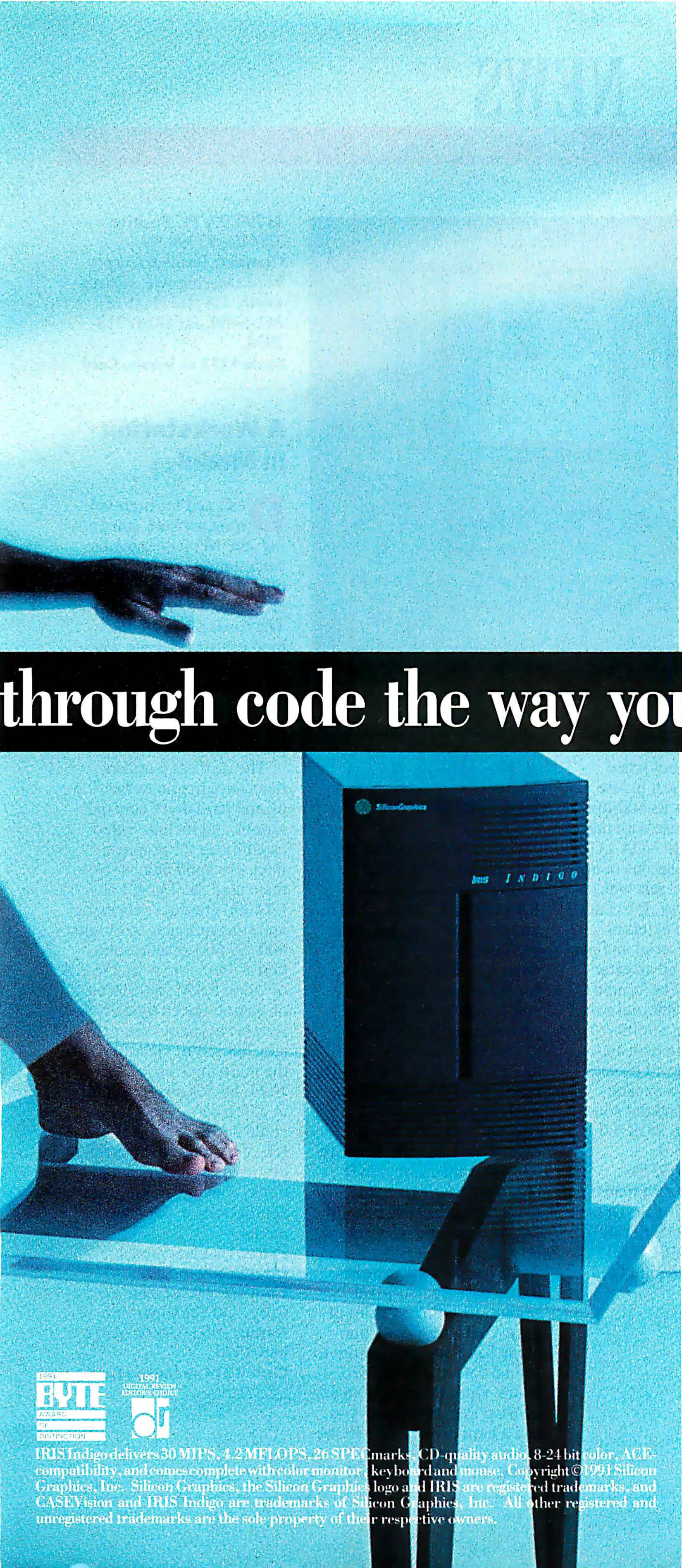
Some call it a dongle. Those who know, call it Sentinel.

RAINBOW TECHNOLOGIES

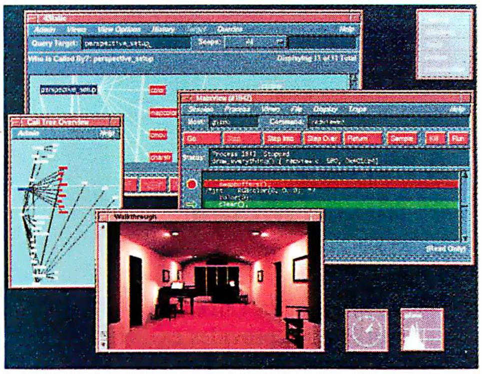
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International offices are located in the United Kingdom, Germany and France.

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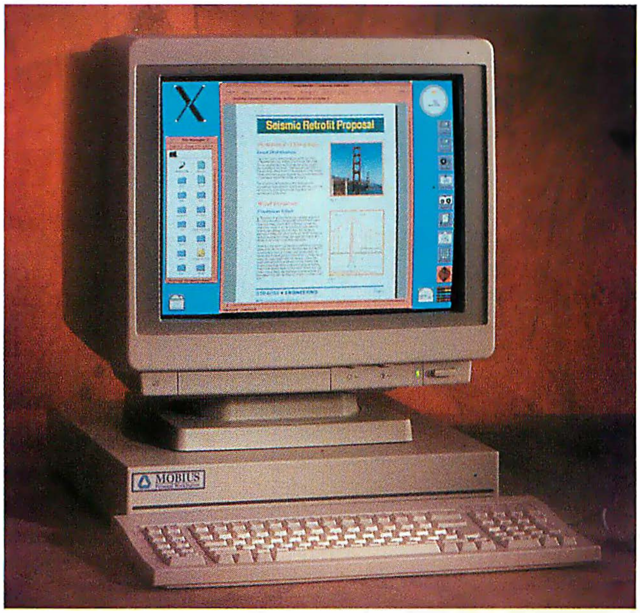
The Mirage IPS Unix workstation provides expandability and Next-like multimedia features. The SPARC-based workstation is built around the 25-MHz LSI chip set.

Available in diskless and disk versions, the Mirage IPS ships with Solaris 1.0 and 8 MB of RAM (expandable to 64 MB). It features a Weitek FPU, a Sparcstation chassis with three SBus slots and room for three internal drives, and a 17-inch flat-screen color display with noninterlaced 1151- by 900-pixel resolution and 256 colors. Also included are an Ethernet port, a SCSI-2 port, two serial ports, and a sound port. The Mirage IPS with disk is preconfigured with a 340-MB hard drive.

Price: Diskless version, $4990; disk version, $6990.

Contact: Mobius Computer Corp., 5635 West Las Positas, Building 4-410, Pleasanton, CA 94588, (800) 662-4871 or (510) 460-5252; fax (510) 460-5249.

Circle 1271 on Inquiry Card.



The Mirage IPS offers object-oriented mixed-media capabilities.

Notebook Carries a New Tempo

The Everex Tempo Carrier notebook features the KeyMouse pointing device and a minimum of 2 MB of RAM in its 5⅓ pounds. The 20-MHz 386SX unit includes a 3½-inch floppy drive and a 40- or 80-MB hard drive.

Designed into the notebook, the KeyMouse uses the *J* key as a pointer controller, giving you multidirectional control when you apply pressure on the edges of the key. For times when you prefer to use a mouse, Everex bundles its 400-dpi two-button mouse with the unit. The backlit VGA LCD screen has resolutions of up to 640 by 480 pixels with 32 shades of gray. Ports are available for an external VGA monitor, serial and parallel devices, and an external keyboard. The Tempo Carrier has an internal expansion slot for a 9600-/2400-bps fax/modem and power-on password protection. Its RAM is expandable to 8 MB, and the notebook ships with DOS 5.0 and Windows 3.0.

Price: Starts at $2795.

Contact: Everex Systems, Inc., 48431 Milmont Dr., Fremont, CA 94538, (800) 821-0806 or (510) 498-1111.

Circle 1272 on Inquiry Card.

A Positive Step Forward

The 25-MHz 386SX PC Positive 320N and 320ND notebooks have RAM expandable to 10 MB and ports for external color monitors. DOS 5.0, Windows 3.0, Microsoft Works for Windows, and a Microsoft Productivity Pack are preloaded on the hard disk.

The PC Positive 320N has 2 MB of RAM, a 40-MB hard drive, a 3½-inch floppy drive, a mouse, an AC adapter, and a carrying case. The deluxe PC Positive 320ND comes with 4 MB of RAM, a 60-MB hard drive, a 9600-/2400-bps fax/modem, and an extra battery. The 9-inch paper-white backlit LCD screens have a 640- by 480-pixel resolution with 32 shades of gray. Each 6½-pound machine has a standby feature to extend battery life to 3½ hours. Options include an expansion system that lets you add a hard drive, a CD-ROM drive, or other device.

Price: PC Positive 320N, $1799.99; PC Positive 320ND, $2399.99.

Contact: Positive Corp., 9174 Deering Ave., Chatsworth, CA 91311, (818) 341-5400; fax (818) 718-2938.

Circle 1273 on Inquiry Card.

A Workstation in Modules

Designed for high-volume network computing, the Netmate modular workstation offers a built-in upgrade path via its interchangeable daughtercards. The cards plug into the motherboard, letting you change the CPU from the basic 20-MHz 16-/32-bit 386SX to a 20-MHz 32-bit 486SX or 25-MHz 32-bit 486 processor.

The diskless workstations have upgrades for floppy and hard drive configurations and include video capabilities for graphics-intensive applications. Netmate uses the Tseng Labs ET4000 graphics processor and runs in Super VGA with 800- by 600-pixel resolution at 16 colors with 256 KB of video RAM; interlaced or noninterlaced mode is selectable at setup. You can add 768 KB of video RAM to the main logic board for 1024- by 768-pixel resolution in 256 colors. Features include 2 MB of 80-ns RAM, 8 KB of on-chip cache memory in the 486SX and 486 units, and an on-chip math coprocessor in the 486 model.

Price: Diskless models from $1699 to $2999.

Contact: Datamedia Corp., 20 Trafalgar Sq., Nashua, NH 03063, (603) 886-1570.

Circle 1274 on Inquiry Card.

Bring Hi-Fi Sound to Your Computer

For those of you who compose music on your computer, use it for multimedia presentations, or do MIDI or voice synthesizing on it, the Bose RoomMate Computer Monitor may fit right into your scheme of things. Incorporating Bose's HVC driver and proprietary distortion-limiting circuitry for a full range of digital output, the speaker includes a built-in amplifier and active equalization circuitry. The unit provides stereo or mono high-fidelity sound, depending on the sound chip in your computer. Magnetically shielded, the 6- by 6- by 9-inch speaker includes built-in volume control.
Price: $339 a pair.
Contact: Bose Corp., The Mountain, Framingham, MA 01701, (508) 879-7330; fax (508) 872-6541.
Circle 1275 on Inquiry Card.



The Bose RoomMate Computer Monitor unlocks your computer's sound.

A Laser Printer with RISC

Mannesmann Tally's MT908 laser printer's enhanced resolution technology gives the illusion of higher than 300-dpi resolution. Combining Hewlett-Packard LaserJet III compatibility with RISC processing performance, the printer uses the company's Enhanced Edge Technology to provide smooth edges for type and graphics in all sizes.

Able to print at 8 ppm, the MT908 has a RISC controller featuring an Intel 80960 32-bit 16-MHz processor. The printer's standard memory is 1 MB, expandable to 5 MB, and 1- and 2-MB upgrade modules are available. The MT908 has eight scalable LaserJet III fonts, 14 resident bit-mapped fonts, and HPGL/2 for shading and filling of fonts and graphics. An optional PostScript-compatible interpreter is available as a daughterboard that plugs into the controller.
Price: $1995; upgrades, $230 to $599.
Contact: Mannesmann Tally Corp., 8301 South 180th St., Kent, WA 98032, (206) 251-5500; fax (206) 251-5520.
Circle 1276 on Inquiry Card.

Magneto-Optical Drive for the Mac

The DataPak MO/128 3½-inch magneto-optical drive for the Macintosh features 128 MB of storage on a removable, rewritable optical disk cartridge the size of a 3½-inch floppy disk. The drive has an average access time of about 30 ms.

Available as an internal drive and in an external configuration, the DataPak MO/128 meets ISO/ANSI standards for 3½-inch optical technology. The external drive is compatible with all Mac computers and includes external SCSI termination; push-button SCSI ID selection; software utilities for formatting, partitioning, and diagnostics; and compatibility with System 7.0. The internal configuration is designed for the Mac Quadra 900 and includes a mounting kit with the necessary installation hardware.
Price: External drive, $1795; internal drive, $1495; cartridge, $129.
Contact: Mass Microsystems, 810 West Maude Ave., Sunnyvale, CA 94086, (408) 522-1200; fax (408) 733-5499.
Circle 1277 on Inquiry Card.

Fast Backup on a SCSI Minicartridge

A 3½-inch SCSI minicartridge tape backup system, the Excel 560 backs up 560 MB of uncompressed data or more than 1 gigabyte of compressed data at 32 MB per minute. The Excel 560's data burst rate exceeds 4 MBps, and it has a sustained user data transfer rate of 567 KBps.

Available in internal and external models, the Excel 560 conforms to the QIC-121 SCSI specification. Downward compatible with current QIC standards, the system is also compatible with major network operating systems.
Price: Internal, $1579; external, $1729.
Contact: Everex Systems, Inc., 48431 Milmont Dr., Fremont, CA 94538, (800) 628-3837.
Circle 1278 on Inquiry Card.

High-Capacity Removable Drives

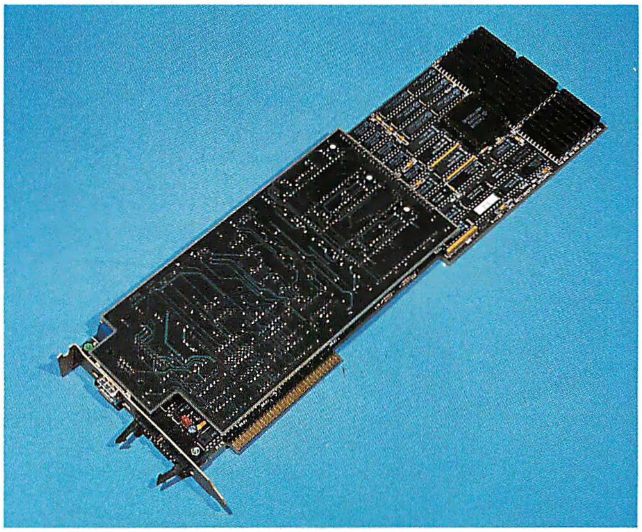
Consisting of four models, the Passport XL removable hard drives for PCs and Macs provide 52, 105, 120, and 240 MB of storage in an internal or external configuration.

The drives provide access times as fast as 9 ms, seek times as low as 17 ms, and a sustained date transfer rate of 1.4 MBps. Quantum uses its proprietary DisCache technology in the drives, which have from 64 KB to 256 KB of RAM, depending on configuration.
Price: $918 to $1897.
Contact: Quantum Corp., 500 McCarthy Blvd., Milpitas, CA 95035, (408) 894-4000; fax (408) 894-3205.
Circle 1279 on Inquiry Card.

Direct Capture to Display

The FG-15XX family of video capture boards for ISA-bus PCs offers direct capture to VGA display in extended modes. The video digitizers' VGA support includes pass-through of VGA, extended VGA, and Super VGA signals. The monochrome models support 256 levels of gray; the color models support 32,768 colors.

Resolution choices on the FG-15XX boards are 512 by 512, 640 by 480, or 768 by 512 pixels. You can capture images in 1/30 second and display them directly from the capture card in real time on a multisync monitor or transfer them to your video card and display them in modes with up to 1024- by 768-pixel resolution. Other features include 1-KB by 24-bit output lookup tables, a four-channel multiplexer, and external capture and event control. The monochrome versions also have two memory pages. Software support includes compatibility with TARGA, TIFF, and PCX files.
Price: $895 to $1295.
Contact: Imaging Automation, Inc., 7 Henry Clay Dr., Merrimack, NH 03054, (603) 598-3400; fax (603) 598-3422.
Circle 1280 on Inquiry Card.



Import images for VGA display with the FG-15XX video digitizer.

SCSI Caching Controller

The TenTime Controller TNT-6000 32-bit SCSI caching controller uses the Motorola MC68340 integrated processor with built-in 32-bit DMA for an average access time of 0.2 ms. The controller's cache is expandable to 80 MB. Other features include compatibility with the WD1003 protocol, support for SCSI-1 and -2 devices, an RS-232 test port, and compatibility with ISA and EISA systems. Options include disk mirroring and Columbia Data Products drivers and software.
Price: With 0.5 MB of cache, $995.
Contact: Laura Technologies, Inc., 3212 South Fair Lane, Tempe, AZ 85282, (602) 438-0889; fax (602) 438-9222.
Circle 1281 on Inquiry Card.

Data Compression for a Notebook

The HardPak data-compression system from Ceram increases hard drive performance by as much as 25 percent and drive capacity by as much as 50 percent, Ceram claims. The board fits into a single 8- or 16-bit ISA or EISA PC expansion slot, including most notebooks and laptops.

Built with Ceram's proprietary CRM1000 high-speed solid-state data compression/decompression engine, the HardPak provides 32 KB of on-board write-through disk cache, which increases to 96 KB after compression. Requiring no modification to your machine's configuration, the HardPak features a user-selectable system address to eliminate potential conflicts with other devices. HardPak, which works with DOS and Windows, is transparent to most programs.
Price: $98.
Contact: Ceram, Inc., 2260 Executive Cir., Colorado Springs, CO 80906, (800) 237-8600 or (719) 540-8500; fax (719) 540-8855.
Circle 1282 on Inquiry Card.

Audio I/O and DSP Together

The AT-DSP2200 DSP accelerator board gives you 25 MFLOPS of processing power. Based on the AT&T WEDSP32C chip, the board is a dedicated numerical computation engine.

The AT-DSP2200 has two channels of 16-bit analog input with 64× oversampling delta-sigma modulating A/D converters and built-in antialiasing filters. With a 92-dB signal-to-noise ratio, −95-dB total harmonic distortion, and ±0.015 amplitude flatness, the board can acquire signals with extremely high accuracy without introducing noise, National says. Additionally, the board has an RTSI serial-data bus interface, flexible triggering through the software on the WEDSP32C chip, and on-chip DMA.
Price: Starts at $2495.
Contact: National Instruments Corp., 6504 Bridge Point Pkwy., Austin, TX 78730, (800) 433-3488 or (512) 794-0100; fax (512) 794-8411.
Circle 1283 on Inquiry Card.

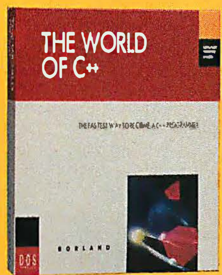
Internal Hard Drives for Macs

The DiamondDrive Internal hard drives from Mass Microsystems are configured for the Mac II, IIci, IIfx, IIcx, and Quadra 700 and 900 computers. With drive mechanisms manufactured by Maxtor, the drives have storage capacities of 120, 210, 320, and 510 MB. Data transfer rates to and from the media reach 2 MBps; data rates to and from the buffer are as high as 5 MBps. Average access times range from 12 ms for the 510-MB drive to 15 ms for the other three drives.
Price: $849 to $2899.
Contact: Mass Microsystems, Inc., 810 West Maude Ave., Sunnyvale, CA 94086, (408) 522-1200; fax (408) 733-5499.
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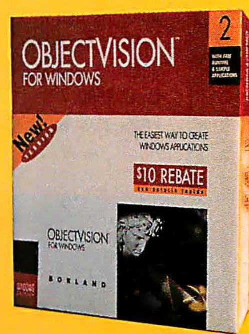
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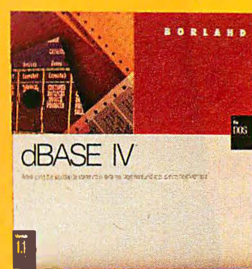
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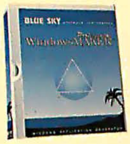
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Price: $69.95.
Contact: Action Laser Products, 1440 South State College Blvd., Suite 3D, Anaheim, CA 92806, (800) 289-1983 or (714) 491-1983; fax (714) 491-0501.
Circle 1285 on Inquiry Card.



The Paper Partner tells you when your printer is out of paper.

66 Fonts in a Cartridge

The latest of Computer Peripherals' JetWare font cartridges, the DeskJet cartridge provides 66 high-resolution fonts for Hewlett-Packard DeskJet 500 ink-jet printers. The cartridge includes CG Times, Univers, Brush Script, and Dom Casual typefaces.

When you plug the cartridge into the DeskJet 500 printer, the printer drivers are automatically installed in the application, giving you access to the font sets, each of which supports as many as 15 symbol sets, including European languages. DeskJet ships with a complete set of drivers for word processing and desktop publishing software such as Windows 3.0 and WordPerfect 5.1.
Price: $149.
Contact: Computer Peripherals, Inc., 667 Rancho Conejo Blvd., Newbury Park, CA 91320, (800) 854-7600 or (805) 499-5751; fax (805) 498-8306.
Circle 1286 on Inquiry Card.

Network Cable Tester

The DX40A Network Cable Tester instantly checks the integrity of any twisted-pair cable wired for Ethernet, 10Base-T, or AT&T 258A applications. After you plug in both cable ends, the unit displays the test results via four two-color LEDs that show whether the cable is wired according to the standard. By combining two units, you can test unshielded twisted-pair wire that has already been installed. The cable tester operates from an internal 9-V alkaline battery.
Price: $39.95.
Contact: L-com, Inc., 1755 Osgood St., North Andover, MA 01845, (508) 682-6936.
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Create detailed temperature charts on your PC with just a few keystrokes using the XR220 Pocket Logger and software. A four-channel pocket-size temperature recorder, the XR220 can record up to 32,256 time-based temperature readings over a time span of less than a day or more than 2 years. The Pocket Logger software lets you transfer the recorded data to your PC. The logger's circuitry protects against signal noise.
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Contact: Pace Scientific, P.O. Box 10069, Charlotte, NC 28212, (704) 568-3691; fax (704) 568-0278.
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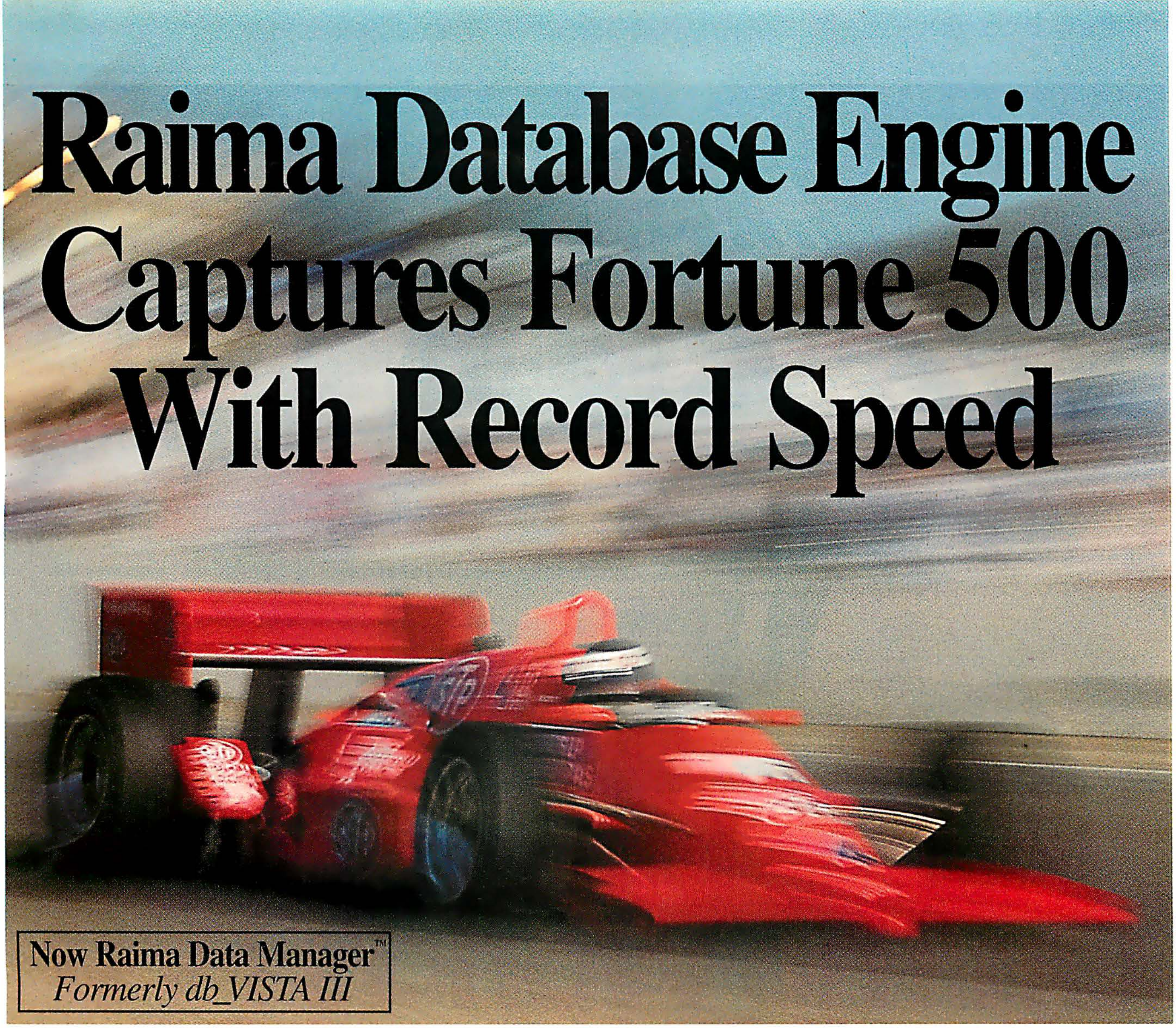
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Price: $129.
Contact: AceCAD, 8 Harris Court, Building A-100, Monterey, CA 93940, (800) 676-4223 or (408) 655-1900; fax (408) 655-1919.
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Measure Electromagnetic Fields

A field radiation monitor that measures potentially hazardous electromagnetic radiation generated by AC power lines, transformers, video display terminals, lamp ballasts, and related products, Walker's MF-5D Portable Fluxmeter measures from the gamma level up to 200 kilogauss. Incorporating an instrument, a sensor, and a cable, the fluxmeter has a frequency response range from DC up to 100 kHz.
Price: $1753; coils, $283 to $600.
Contact: Walker Scientific, Inc., Rockdale St., Worcester, MA 01606, (800) 962-4638 or (508) 852-3674; fax (508) 856-9931.
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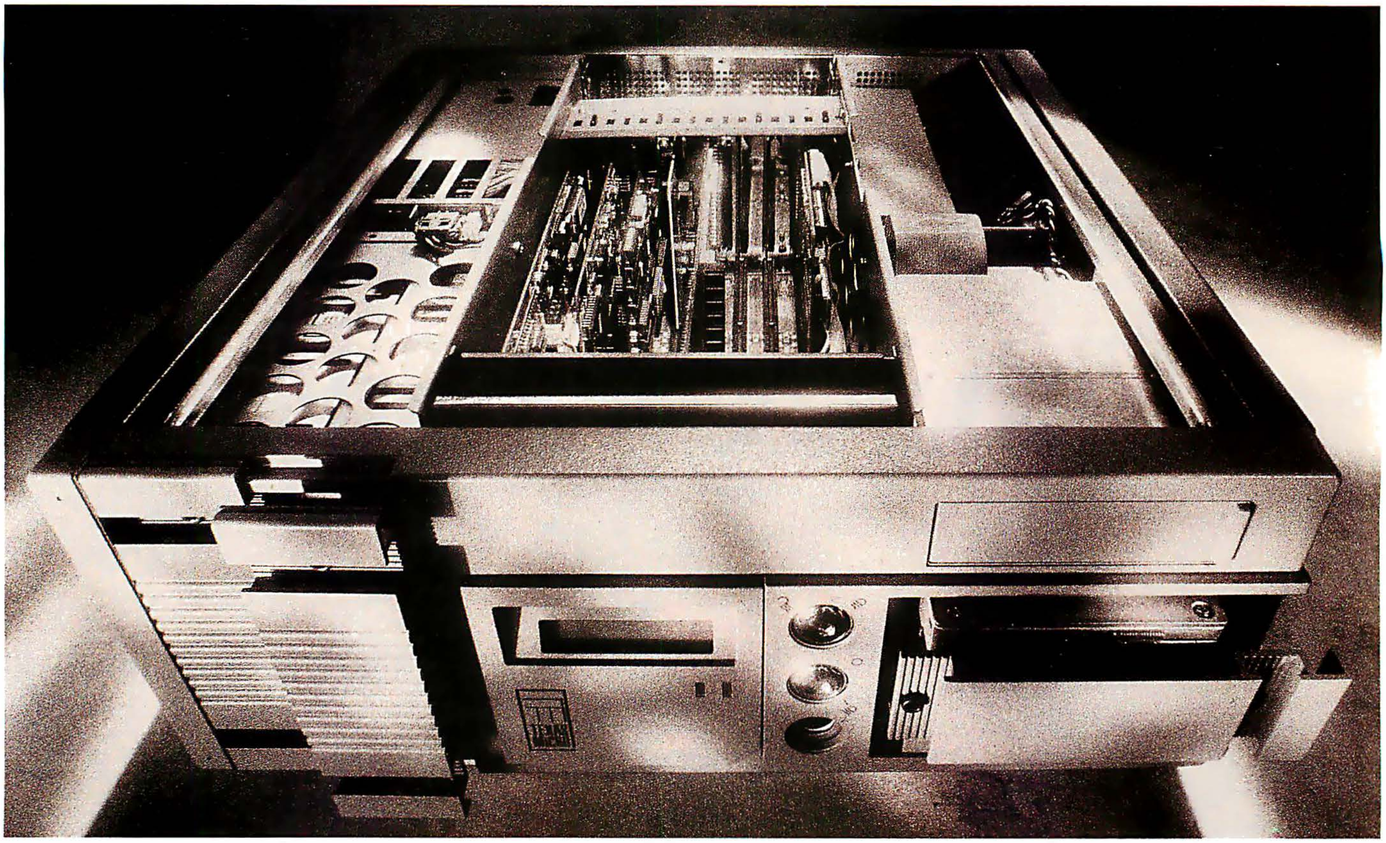
Specifications Relational B-tree indexing. Network data model. Relational SQL query and report writer. Single & multi-user. Automatic recovery. Built-in referential integrity. **Supports:** VMS, QNX, ULTRIX, UNIX System V, Berkeley 4.2, AIX, SunOS, SCO, MS DOS, MS Windows, and OS/2. **Most C Compilers and LANs supported.**

Raima Corporation 3245 146th Place S.E., Bellevue, WA 98007 USA **(206)747-5570** **Fax: (206)747-1991**

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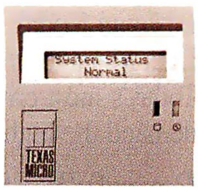
Inside Information On The World's First Fault Tolerant PC.

INTRODUCING THE FAULT TOLERANT PC FROM TEXAS MICRO. If you're the kind of person who absolutely has to protect your data and applications, your PC has arrived.

It will save you from head crashes. It will save you from blackouts and user errors. It will save you from dust, heat, vibration, bad sectors, power fluctuations, bumps and bruises.

It thrives where ordinary PCs knuckle under. It's the pit bull of PC-dom. It's the FTSA™ PC from Texas Micro, and it redefines fault tolerance.

THE FTSA PC IS BUILT FAULT TOLERANT FROM THE GROUND UP. It's not another PC with add-ons. Instead, the FTSA PC is based on Texas Micro's own Fault Tolerant System Architecture™, which operates at the BIOS level, creating an umbrella of fault tolerance ordinary PCs can't begin to compete with.



The diagnostic system keeps you apprised of power, data and component status.

Each component is part of a synergistic unit, directed by a specialized, DOS-compatible BIOS. This makes FTSA transparently

For Complete Inside Information, Place This Card Inside Your Mailbox.

For free information about the FTSA PC, send in this card; FAX this card to 1-713-933-1029; or for immediate attention, call 1-800-627-8700.

I PURCHASE COMPUTERS FOR:
☐ Internal company use ☐ Resale ☐ Both

I AM INTERESTED IN FAULT TOLERANCE FOR: ☐ Stand alone PC ☐ Network server ☐ Both

APPLICATIONS YOU ARE RUNNING: ______________________

DO YOU CURRENTLY HAVE ANY FAULT TOLERANT PROTECTION?
☐ Yes ☐ No

IF YES: ☐ UPS ☐ Disk mirroring ☐ Redundant power
☐ Other ______________________

PROCESSOR: ☐ 386 ☐ 386 SX ☐ 486 ☐ Other

CONFIGURATION: ☐ Desktop ☐ Rackmount ☐ Tower

IMPORTANT SPECIFICATIONS: ☐ Data security ☐ Industrial
☐ System availability ☐ Power management
☐ Other ______________________

PURCHASE TIMEFRAME: ☐ 30 days ☐ 60 days ☐ 1 year

NAME ______________________

TITLE ______________________

COMPANY ______________________

PHONE ______________________

FAX ______________________

ADDRESS ______________________

CITY ______________________

STATE ______________ ZIP ________

B392

Resellers, Give Yourself The Inside Track To PC Fault Tolerance.

Texas Micro has reseller programs and incentives that will interest you. Simply mail this card, FAX it to 1-713-933-1029 or call 1-800-627-8700.

I AM A/AN: ☐ OEM ☐ VAR ☐ Systems Integrator
☐ Other ______________________

ON WHAT APPLICATIONS DO YOU PRIMARILY FOCUS? ______________________

I AM INTERESTED IN FAULT TOLERANCE FOR: ☐ Stand alone PC
☐ Network server ☐ Both

DO YOU CURRENTLY PROVIDE FAULT TOLERANT SOLUTIONS?
☐ Yes ☐ No

IF YES: ☐ UPS ☐ Disk mirroring ☐ Redundunt power
☐ Other ______________________

DO YOU WORK WITH A SPECIFIC PC BRAND TO CREATE FAULT TOLERANT SOLUTIONS? ☐ Yes ☐ No

NAME ______________________

TITLE ______________________

COMPANY ______________________

PHONE ______________________

FAX ______________________

ADDRESS ______________________

CITY ______________________

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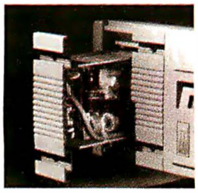
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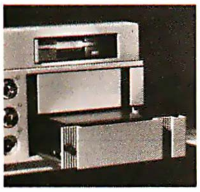
TEXAS MICRO
10618 ROCKLEY RD.
HOUSTON, TX 77099-9986



The FTSAPC has two externally removable power supplies with a built-in backup battery.

adaptable, giving it numerous ways to detect and correct system faults, without user intervention. The result is a level of intelligent data and system protection never before achieved in PCs. And FTSA does it all without sacrificing performance.

THE FTSA PC IS FIERCELY PROTECTIVE OF YOUR DATA. With selective component redundancy and monitoring, FTSA virtually guarantees data integrity. FTSA begins with a data-mirroring disk array, which is supplemented by sophisticated auditing and archiving systems that make your data impervious to system crashes and corruption.



A disk array mirrors data to protect you from head crashes.

Employing a unique strategy called "data change auditing," FTSA keeps bit-level records of every data transaction to the disk. This allows you to roll back the record to any point in time and reconstruct lost files, even if you deleted them.

To further protect data and applications, FTSA allows you to easily program special "save" commands that execute during any shutdown sequence. Should system shutdown become imminent, FTSA will automatically write all data to the hard drives and exit your applications safely.

THE FTSA PC KEEPS YOU UP AND RUNNING. This makes it ideal for mission-critical applications and workgroup LANs. In fact, FTSA provides a fault tolerant solution for LANtastic and NetWare Lite right out of the box.

Should normal power fail, FTSA has a built-in battery backup to keep you on-line long enough to secure a safe shutdown. The disk array virtually eliminates downtime due to hard disk crashes.

Every component is monitored and regulated by a coprocessor-driven diagnostic system that provides early indications in English of any impending problem, such as disk wear, power fluctuations and potential component failure.

FTSA has several cabinet configurations to conform to different environmental specifications—from desktops to industrial sites.

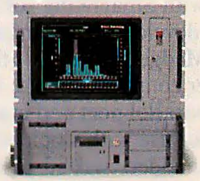
FTSA LETS YOU POP IT AND SWAP IT. The FTSA PC's modular design and passive backplane give you plug-and-play access to every major component, including CPU and option cards, which reduces Mean Time To Repair to under 10 minutes. And gives you complete CPU upgradability.



FTSA Desktop



FTSA Micro-tower



FTSA Rockmount

- 8-slot passive backplane
- 386/486 upgradable CPUs
- SCSI hard drives from 80-525 MB
- 1.44 MB floppy
- Up to 1024 x 768
- Redundant power supplies
- Built-in backup batteries

intel inside™

THE BIGGEST BREAKTHROUGH IS THE PRICE. FTSA truly stands alone. In fact, to match its fault tolerance, you'd have to spend 5 to 10 times more and get a minicomputer. No wonder the FTSA PC was awarded Best Desktop PC at Comdex by Byte Magazine.

BEST OF THE INTERFACE GROUP BYTE COMDEX/Fall '91 Winner

Detailed information about the FTSA PC and our free "Guide to Fault Tolerant Computing" are just a phone call away. Find out today how you can benefit from a PC that has inner strength.

TEXAS MICRO

Get An Insider's Look At The FTSA PC. Call 1-800-627-8700.

Get a Grip on Token Ring

Featuring Xircom's Tractor Grip for one-handed installation, the Pocket Token Ring Adapter II is software switchable, letting you connect your laptop or desktop computer to a 16- or 4-Mbps Token Ring network. Preconfigured with SmartRing software (developed by Xircom and Madge Networks), the adapter connects to your PC's parallel port and is available for use with shielded or unshielded twisted-pair wiring. The unit has top-panel diagnostic lights.
Price: $845.
Contact: Xircom, 26025 Mureau Rd., Calabasas, CA 91302, (818) 878-7600; fax (818) 878-7630.
Circle 1291 on Inquiry Card.



The software-switchable Pocket Token Ring Adapter II links laptops to LANs.

V.42 Power in Your Pocket

The Practical Pocket Modem (PM2400PPM) V.42 SendFax from Practical Peripherals puts in a pocket-size package a full-function 2400-bps data modem with 9600-bps fax transmission capabilities. The data modem supports V.42 error correction and V.42bis data compression.

Powered by a plug-in wall power pack or a nickel-cadmium battery pack—both are included—the PM2400PPM V.42 SendFax weighs 4 ounces and measures 2¼ by 3 by ¾ inch. The unit is compatible with all Group 3 fax systems as well as with the Hayes Smartmodem. Menu-driven Quick Link II fax communications software comes with the modem.
Price: $299.
Contact: Practical Peripherals, 31245 La Baya Dr., Westlake Village, CA 91362, (818) 706-0333; fax (818) 706-2474.
Circle 1292 on Inquiry Card.



The lightweight Practical Pocket Modem V.42 SendFax does heavy-duty faxing.

Wire Converter

The 10305 Ethernet external 10Base-T Media Attachment Unit enables integrators to convert existing coaxial or autonomous unit interface wiring to 10Base-T via the AUI port. The 10305's ability to detect collisions or cabling malfunctions maintains the network's integrity. The MAU features a diagnostic LED that indicates link, jabber, and reversed polarity and uses standard unshielded twisted-pair and shielded twisted-pair wire.
Price: $100.
Contact: Network Interface Corp., 15019 West 95th St., Lenexa, KS 66215, (800) 343-2853 or (913) 894-2277; fax (913) 894-0226.
Circle 1293 on Inquiry Card.

Dove Flies to PCs

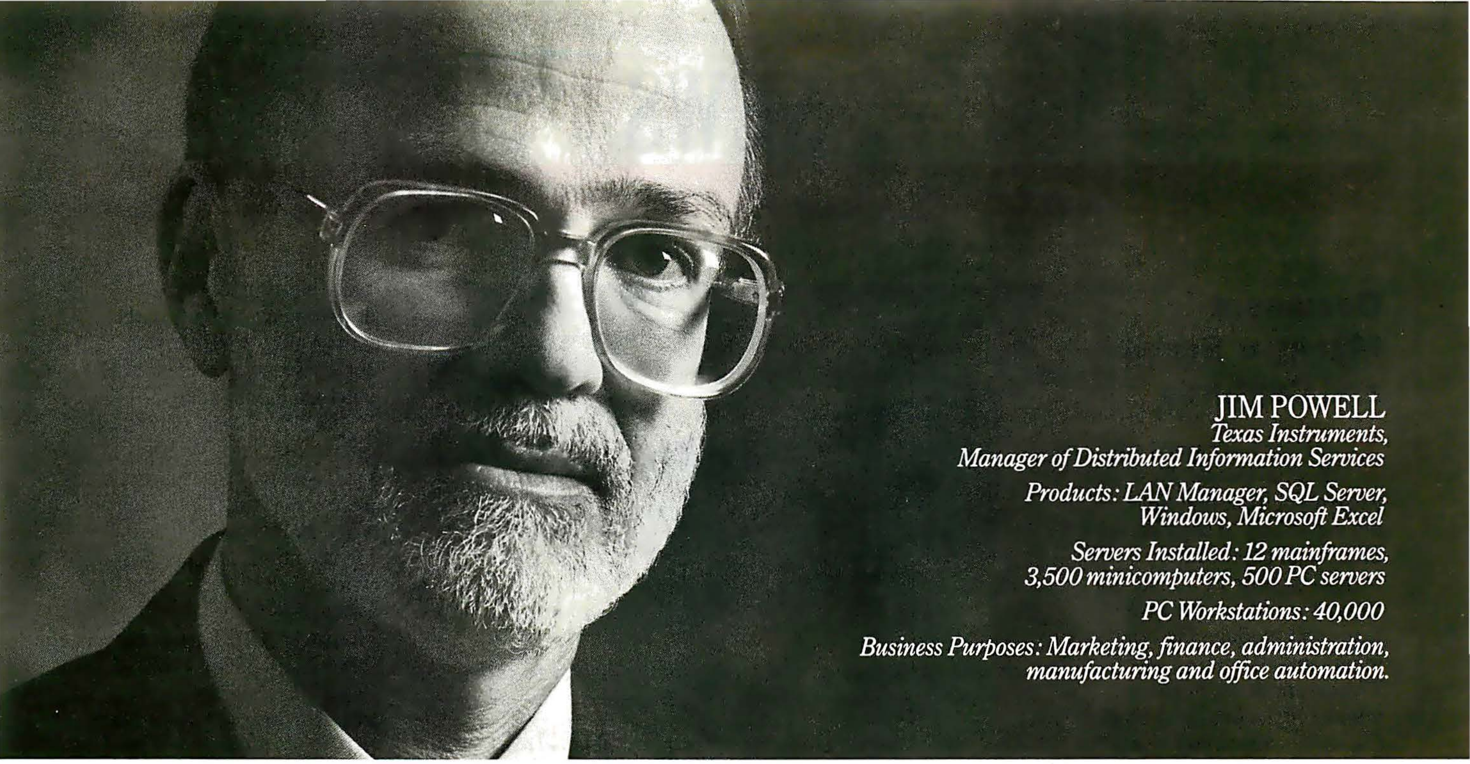
DoveFax for DOS supports the Class 1 fax/modem standard in its 9600-bps fax/2400-bps data modem. Featuring full background send and receive capability, call grouping and scheduling, and customizable cover pages, DoveFax for DOS automatically updates logs of incoming and outgoing faxes.

The fax driver in DoveFax for DOS loads into expanded memory, providing immediate access to the software's capabilities; pop-up DOS application support lets you fax directly from your applications. MNP level 5 data correction and compression are included in the software.
Price: $299.
Contact: Dove Computer Corp., 1200 North 23rd St., Wilmington, NC 28405, (919) 763-7918; fax (919) 251-9441.
Circle 1294 on Inquiry Card.

Da Vinci eMail Upgraded

Da Vinci eMail 2.0 for DOS offers increased power and modularity via its open systems architecture, which provides a set of application programming interfaces that let you customize the product as well as develop third-party gateways. In the open systems design, the core code of the product is connected to transmission, directory, storage, and network operating-system services.

Features new with version 2.0 include folders for organizing and archiving received mail, message storage that automatically recovers and reuses space from deleted messages, enhanced user directories, an edit menu with a spelling checker, display in 43- or 50-row mode, and MHS support. Da Vinci eMail 2.0 is fully compatible with earlier versions.
Price: 10-user starter pack, $295.
Contact: Da Vinci Systems Corp., P.O. Box 17449, Raleigh, NC 27619, (800) 328-4624 or (919) 881-4320; fax (919) 787-3550.
Circle 1295 on Inquiry Card.



Texas Instruments' top executives get to the bottom line instantly with Microsoft client-server computing.

Every business wants to know the bottom line. Thanks to Microsoft's client-server computing solution, Texas Instruments' upper management sees it instantly. Right on their own PCs.

"PEOPLE DON'T JUST WANT ACCESS TO DATA. THEY WANT TO CREATE IT, CHANGE IT AND MAKE IT THEIR OWN."

They can also track inventory, monitor sales, check raw material prices and find other information needed to make decisions.

And that's how Jim Powell likes it. Because as Texas Instruments' Manager of Distributed Information Services, it's his job to provide his coworkers with the computer support they need. And with Microsoft client-server computing, his job is a lot easier.

Two years ago, a lot of people at Texas Instruments found the mainframes difficult to use and inflexible.

So Jim started to look at possible solutions. He wanted to find a system that would utilize their existing equipment, allow MIS to rapidly develop applications, and provide the end users with an easy-to-use interface.

He discovered Microsoft client-server computing was just what Texas Instruments needed. The Windows™ environment was placed on the desktops and Microsoft® LAN Manager and SQL Server were integrated into the system.

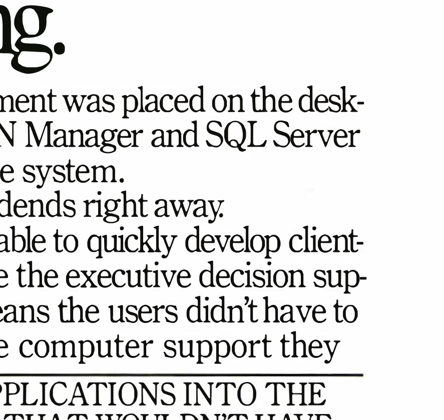
There were dividends right away.

Jim's group was able to quickly develop client-server applications, like the executive decision support system. Which means the users didn't have to wait forever to get the computer support they needed. And with Windows, the information on the mainframes was easier to access.

"NOW I CAN PUT APPLICATIONS INTO THE HANDS OF PEOPLE THAT WOULDN'T HAVE GOTTEN THEM OTHERWISE."

Simply put, Jim was able to get the right information, to the right people, the right way.

If you'd like a case study on Texas Instruments' migration to Microsoft's client-server solution, call us at (800) 992-3675, Dept. X32. We'll tell you how you can profit from their experience.



Microsoft®

Document Manager Scans and Captures

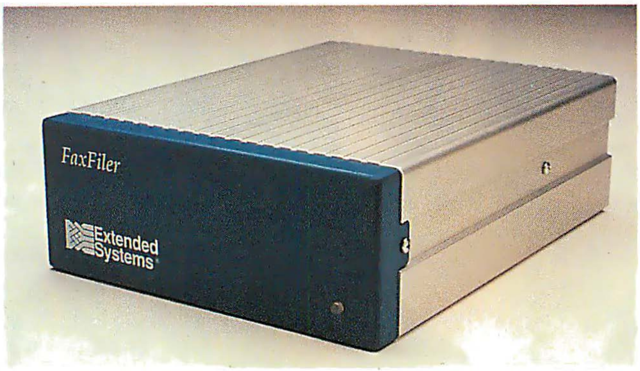
FaxFiler has gained additional duties. Now able to give your fax machine the capability to scan documents and capture fax images to your PC, FaxFiler can still send and receive faxes and manage fax documents in a database file. The components FaxScan, which only scans, and FaxCapture, which only scans and captures, are also available separately.

Compatible with DOS and packaged with Windows 3.0, FaxFiler enables you to use your existing fax machine as a hard-copy input device to your PC fax card without requiring an additional phone line. You can save fax documents to your hard disk in standard formats for viewing later, resending, or editing, and you can save images in TIFF. FaxFiler automatically captures incoming and outgoing faxes in DOS and Windows and simultaneously receives fax documents at your computer system and fax machine.
Price: $695; FaxScan, $395; FaxCapture, $495.
Contact: Extended Systems, 6123 North Meeker Ave., Boise, ID 83704, (800) 235-7576 or (406) 587-7575; fax (208) 377-1906.
Circle 1296 on Inquiry Card.

LAN Adapter for Notebooks

A flexible intelligent cable and a lightweight parallel port connector on the NotePort Pocket LAN adapter let you easily join your notebook computer to a network. Supplied with connections for 10Base-T and coaxial Ethernet LANs, the NotePort connects to the notebook's parallel port and automatically senses the cabling interface that you select.

The NotePort integrates its power supply into its 3½- by 5½- by 1½-inch form. Preconfigured with NetWare software drivers, the unit's one-step installation procedure enables you to quickly link up to your LAN.
Price: $395.
Contact: Kodiak Technology, 1338 Ridder Park Dr., San Jose, CA 95131, (408) 441-6900; fax (408) 441-1273.
Circle 1297 on Inquiry Card.



Scan and capture images to a PC with the newest FaxFiler.

Token Ring Host Module

The Model 3505A UTP Host Module addresses problems that can occur with unshielded twisted-pair (UTP) wiring at high speeds, such as network signal distortion and near-end cross talk. The module provides retiming at each Token Ring hub port, simplifying installation and configuration management, as well as providing consistently reliable network performance, according to SynOptics.

When installed in a SynOptics System 3000 intelligent hub, the Model 3505A supports as many as 132 Token Ring stations as far away as 100 meters from the hub, using the UTP wiring found in most buildings. Compatible with SynOptics' Model 3505 UTP Token Ring Host Module, the Model 3505A can be connected to the 3505 module in a single ring or hub.
Price: $2095.
Contact: SynOptics Communictions, Inc., 4401 Great American Pkwy., Santa Clara, CA 95052, (408) 988-2400; fax (408) 988-5525.
Circle 1298 on Inquiry Card.

X Server for Microsoft Windows

The XoftWare for Windows X Window System server lets you work in Windows 3.0 or 3.1 to cut and paste between X and Microsoft Windows applications. Using Windows as a local window manager, you can configure icons to start specific network-based X applications that have the look and feel of Windows.

You can start X applications in XoftWare's single- or multiple-window mode, and you can configure the XoftWare for Windows server for your preferred X start-up mode, such as XDMCP, telenet, rsh, rexec, or passive. As a Windows user, you can transparently access X-based Unix and VAX applications, integrating the environments as you work.
Price: $495.
Contact: AGE Logic, Inc., 9985 Pacific Heights Blvd., Suite 200, San Diego, CA 92121, (619) 455-8600; fax (619) 597-6030.
Circle 1299 on Inquiry Card.

A New Network Archivist

Version 2.0d of the Network Archivist extends the software's intelligent storage management features. The new version has a prioritized list of tapes to use when full system, volume, or disk restores are requested, and it recommends the tape sequence that will ensure the fastest restores. This extension ensures that the volume or system is restored to its original state.

Other new features include the ability to restart a restore if the restore operation is aborted and the TNARECOV utility, which can run unattended restores. Additionally, export operations now record all NetWare security, rights, and attribute information.
Price: $995; upgrades available.
Contact: Palindrome Corp., 850 East Diehl Rd., Naperville, IL 60563, (708) 505-3300; fax (708) 505-7917.
Circle 1351 on Inquiry Card.

RISC FREE!

NEW!!

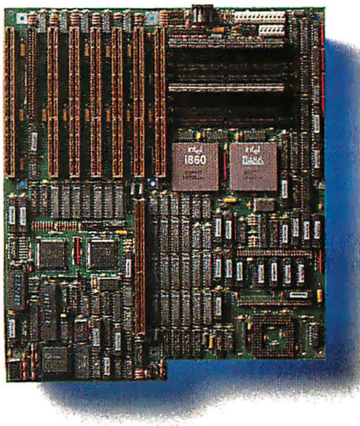
- •4860 FrameBuffer with ADI/860 for AutoCAD rel.11
- •4860 FrameBuffer support with RenderSTARII/860 and CADART/860
- •4860 AutoCAD workstations from $4995.

AutoCAD is a trademark of AutoDESK Inc. RenderSTARII/860 is a trademark of Modern Medium

Free i860™ Processor and i860/APX Software!
By now, you've probably heard about our industry-first 4860™ MotherBoard that packs the power of the Intel 80486 CPU with the Intel 80860 RISC processor (i486™+ i860=4860).

What you haven't heard is that, for a limited time, when you buy a 4860 MotherBoard with 8MB of RAM, Hauppauge will give you an i860 RISC processor and the i860/APX operating system at no additional cost.

Why *give* you this capability? Because you'll enjoy a level of processor performance never before seen in a PC. Our bet is that you'll be so impressed, you'll come back for more!



A PC Revolution: In the PC environment, the 4860 is a 486-based MotherBoard with the new EISA I/O bus. It runs over 2 times faster than 386 computers and delivers mainframe power for applications including CAD, LAN and desktop publishing. This board is fully compatible with DOS, IBM's OS/2, Novell Netware and SCO UNIX. What's more, Hauppauge's 4860 supports up to 64 MBytes of memory *without* a RAM expansion board.

RISC-Y Business: The i860 processor is ideal in complex applications, performing up to 25 million floating-point operations per second. It adds to the power of the 486, so you can run rings around ordinary PCs.

By adapting Intel's APX (Attached Processor Executive) software to our 4860 MotherBoard, we've created a way to exploit the power of the i860 to give you *practical* multiprocessing. In fact, i860/APX provides a base for entirely new applications made possible by the advent of the i860 RISC processor.

Technical Features: 25 or 33MHZ 486/860 • 4 Mbytes of high speed RAM expandable to 64 Mbytes shared between i486 and i860 processors • Socket for optional Intel Turbo Cache 485™ and Weitek 4167 • **8 EISA I/O** slots • 64-bit expansion slot for optional high-speed graphic frame buffer • 1 parallel, 2 serial ports and a built-in PS/2-style mouse port.

Enjoy a RISC-free investment. Our 4860 MotherBoard is designed with the world's highest performing microprocessors. So you can have the world's highest performing PCs and workstations.

For more information, call **1-800-443-6284**.

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Trademarks: OS/2: IBM • Intel 386, i486, i860 and Turbo Cache 485™: Intel Corp. • DOS and Xenix: Microsoft Corp. • 4860, 4860 MotherBoard: Hauppauge

Circle 61 on Inquiry Card.

C++ Upgrades from Borland

The release of Turbo C++ for Windows and C++ and Application Frameworks 3.0 further establishes Borland in the Windows development market. The two applications development and maintenance products feature Borland's object-oriented C++.

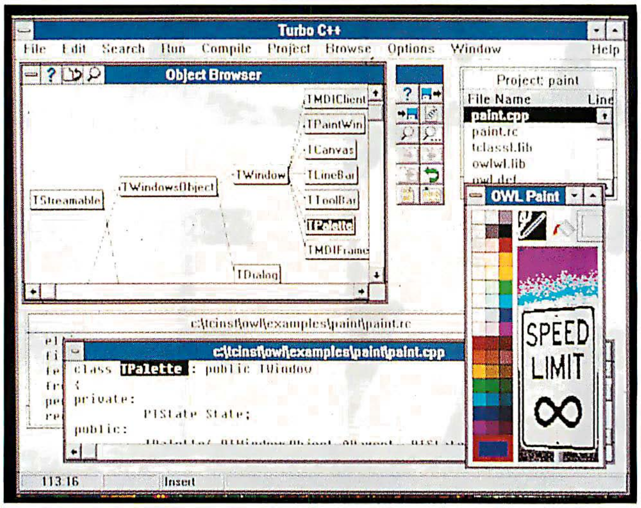
Turbo C++ for Windows offers a GUI development environment with visual programming tools and a library that enables DOS-based C and C++ programs to run in Windows. Turbo C++'s ObjectWindows framework provides built-in objects, and Resource Workshop lets you create Windows resources such as icons, fonts, and bit-mapped graphics without writing code.

C++ and Application Frameworks 3.0 includes all the programming tools provided in Borland C++ 3.0, plus the ObjectWindows and TurboVision applications frameworks. The frameworks let you define a standard user interface for your operating system by providing interface building blocks, fundamental data structures, and support for object-oriented programming.

Price: Turbo C++ for Windows, $149.95; C++ and Application Frameworks 3.0, $749.

Contact: Borland International, P.O. Box 660001, Scotts Valley, CA 95066, (408) 438-8400; fax (408) 439-9343.

Circle 1300 on Inquiry Card.



Turbo C++'s ObjectBrowser lets you visually browse through class hierarchies, functions, and variables.

Expert-System Shell Features Ease of Use

Mentor's everyday syntax, automatic menu creation, and development features simplify the task of creating your own expert applications, according to its developer. The program lets you use backward and forward chaining, a procedural language, and object-based reasoning to build applications with multiple knowledge bases. Mentor features interfaces to Lotus 1-2-3, dBase, and ASCII files, and it can interface with files written in C, assembly, FORTRAN, and Pascal.

The program is available in two versions. The personal version lets you develop and run expert applications on a single PC running DOS; the developer's version lets you develop and distribute your applications to other PCs. Mentor is not currently network compatible.

Price: Personal version, $495; developer's version, $1495.

Contact: Icarus Corp., 1 Central Plaza, 11300 Rockville Pike, Rockville, MD 20852, (301) 881-9350; fax (301) 881-2542.

Circle 1301 on Inquiry Card.

A System 7.0 FORTRAN Compiler

Language Systems FORTRAN 3.0 is the first System 7.0–savvy compiler language for the Macintosh operating system, according to its developer. LSF lets you compile applications that include such System 7.0 features as Publish/Subscribe and Apple events. Enhancements to the compiler include 68040 code generation, advanced debugging, and Cray pointers. LSF's interface to the Mac Edition manager lets you Publish a data file and Subscribe to graphing or spreadsheet applications with automatic data updating.

Price: $495.

Contact: Language Systems Corp., 441 Carlisle Dr., Herndon, VA 22070, (703) 478-0181; fax (703) 689-9593.

Circle 1302 on Inquiry Card.

ART-IM Comes to Windows and Unix

The ART-IM knowledge-based system development tool is available now in Windows and Unix versions. ART-IM/Windows 2.5 and ART-IM/Unix 2.5 use Inference's Case-Based Reasoning technology, which lets you construct knowledge bases from case histories and access those histories when similar situations occur. According to Inference, CBR speeds up development of applications that incorporate experience-based advice, such as help desks and engineering design systems.

In addition to CBR, ART-IM includes rule-based reasoning, procedural programming, and hypothetical reasoning with consistency management. The program supports integration with external databases and provides automatic conversion of external data into ART-IM knowledge-base objects.

ART-IM/Windows supports the environment's Dynamic Data Exchange with applications such as spreadsheets, word processors, and databases. The Unix version features an on-line tutorial and provides support for Sun-4 Sparcstation, HP 9000, IBM RISC System/6000, and other Unix platforms.

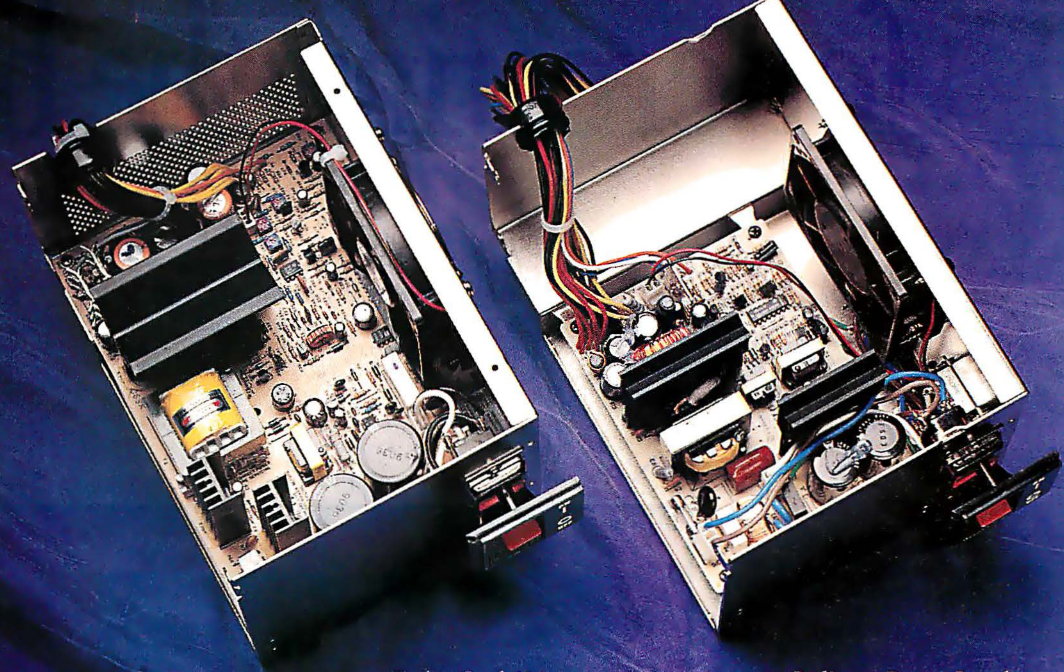
Price: Windows version, $8000; Unix versions, $12,500 and up.

Contact: Inference Corp., 550 North Continental Blvd., El Segundo, CA 90245, (213) 322-0200; fax (213) 322-3242.

Circle 1303 on Inquiry Card.

LOOK AT THE INSIDE STORY ON POWER SUPPLIES.

What power supply is inside your computer? If you are like most people, you don't know, and frankly, don't care. But, because your computer's power supply is a critical system component, what you don't know, may hurt you. An inferior power supply can cause interference, rebooting, hard drive errors, and other nasty hard-to-track problems. So why take chances? Call the power supply specialists at PC Power and Cooling today.



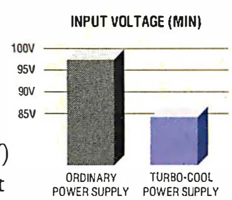
HERE ARE TEN GREAT REASONS TO SELECT THE INDUSTRY'S BEST, THE TURBO-COOL™ 300 AND TURBO-COOL™ 450.

1. 50% TO 100% MORE POWER

The more power, the better! Our high-capacity units start drive motors with ease, run cooler, last longer, and allow for future expansion.

2. BUILT-IN LINE CONDITIONING

Turbo-Cool power supplies won't skip a beat when the line voltage sags. Their wide input range (85-135V, 170-270V) and heavy-duty input components protect your PC and its data from sags, surges and spikes.



3. FCC-B AND VDE-B LINE FILTER

A dual-stage EMI filter keeps electrical noise well below agency standards.

4. INDEPENDENT REGULATION

Turbo-Cool's superior independent-regulation design keeps output voltage tolerances 20 times tighter than that of an ordinary power supply. This exceptional stability improves hard drive reliability during critical access periods.

5. ULTRA-CLEAN DC OUTPUT

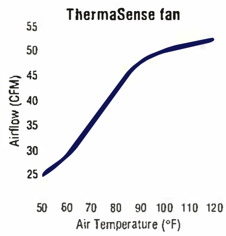
A dual-stage output filter ensures that sensitive computer chips receive pure, low-ripple power.

6. PROTECTION CIRCUITRY

Our units offer the most complete protection from dangerous overvoltage, overcurrent, and short circuit conditions.

7. THERMASENSE™ COOLING FAN

The Turbo-Cool 300 features ThermaSense, our high-capacity, thermostatically-controlled, variable-speed fan. It's ideal! High-performance systems operate up to 35° cooler while standard ones run as much as 75% quieter.



8. UL/CSA/TUV APPROVALS

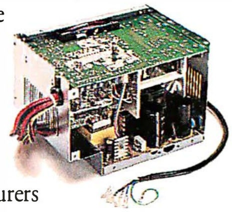
Our high-capacity units are safety approved by not only UL, but also by Canada's CSA and Germany's strict TUV.

9. TWO-YEAR WARRANTY

Turbo-Cools are designed and tested for MTBFs of over 100,000 hours. They come with a no-hassle 2-year warranty and a 30-day money-back guarantee.

10. GREAT VALUE

Loaded with premium features, a Turbo-Cool power supply will upgrade the performance of your PC or LAN file server at a retail cost of only 55¢ to 80¢ per watt. You'll be powered by a unit that is popular with award-winning PC manufacturers and recommended by experts such as the PC Magazine Advisor!



Turbo-Cool 450

PC POWER & COOLING, INC.

5995 Avenida Encinas, Carlsbad, CA 92008 • (619) 931-5700 • (800) 722-6555 • Fax (619) 931-6988

Circle 93 on Inquiry Card (RESELLERS: 94).

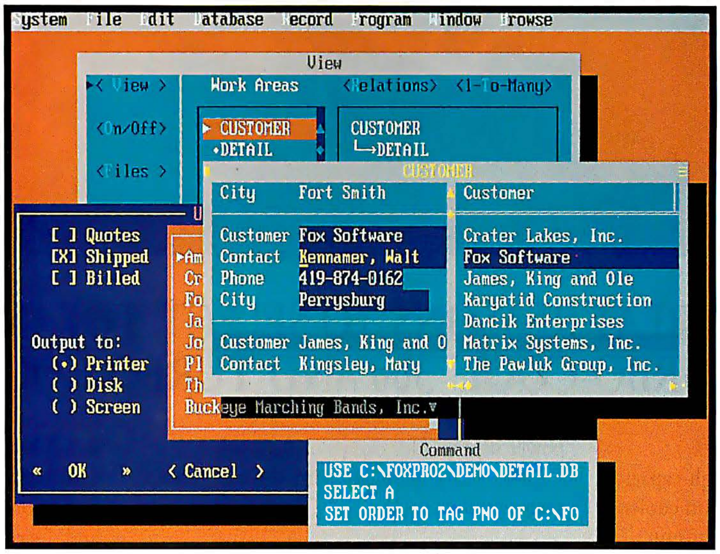
We never dreamed for creating the best PC

FoxPro 2.0 is the state-of-the-database-art, an object-oriented, event-driven DBMS that runs in DOS to protect your information systems investments.

Object-oriented, event-driven operation means that you get the benefits of a Graphic User Interface (GUI) on your DOS PCs, and code that's reusable from application to application.

Rushmore query optimization is unique to FoxPro and gets your answers as much as hundreds of times faster than competitive products.

4GL Tools (Fourth Generation Language) simplify the creation of Mac-like applications on your DOS PCs, using keyboard shortcuts or a mouse.



For users, the View window makes it easy to work with multiple tables of data, RQBE (Relational Query By Example) simplifies the creation of business queries.

Event-driven operation allows you to work with any number of resizable, scrollable windows, get to all of your data all of the time.

FoxPro 2.0 runs your industry-standard dBASE programs today, lets you build on your current systems for your needs tomorrow.

Optional Distribution Kit creates stand-alone .EXE files for distributing your applications.

Application Program Interface (API) links to external libraries written in C or assembler. Third-parties are currently developing communications, client/server access and other packages. (Optional Library Construction Kit available.)

Applications you write in FoxPro 2.0 can exchange data with our FoxBASE+/Mac on a LAN today, will run virtually unchanged under our Windows, Mac and UNIX versions currently in development (no release date yet).

Response to FoxPro 2.0 has been overwhelmingly favorable.

And that's the problem: the response has been overwhelming.

We're hearing of callers being on hold for 20 minutes or longer!

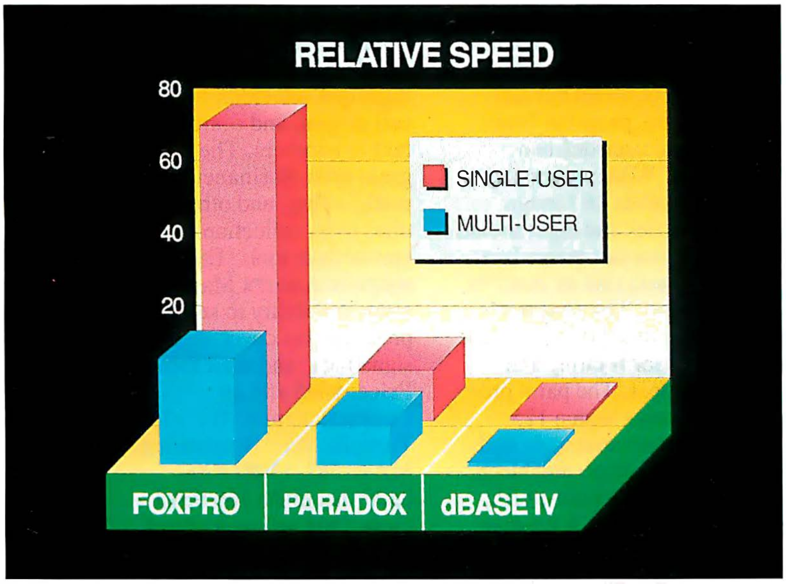
And this in spite of ramping up our support months in advance of the release.

Well, we're adding another 40 phone lines and hiring more people. And if that's not enough, we'll add even more.

In the meantime, we'd like to say

we'd be apologizing database in the world.

Results from an extensive suite of query tests independently performed by Micro Endeavors, Inc. and published in the 8/91 issue of Data Based Advisor.



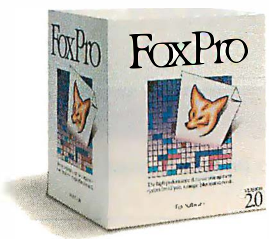
FoxPro 2.0 is far faster than the other PC database management systems and raw compilers like Clipper, both single-user and on a LAN.

"Thanks" to the tens of thousands of you who put up with the wait, and "Sorry" to those who didn't.

But please try again. We think we've got things under control now.

And FoxPro 2.0 really is worth the wait.

Call 1-800-837-FOX2 or 419-874-0162 again. (We believe we've fixed it.)



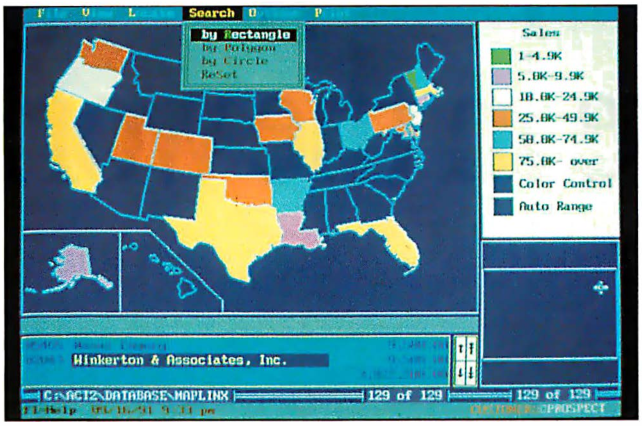
FOX SOFTWARE

Query benchmark tests performed by Micro Endeavors, Inc. (215) 449-4680. FoxPro and FoxBASE+/Mac are trademarks of Fox Holdings Inc.; other products and services are not. © Fox Holdings Inc. 1991.

Circle 56 on Inquiry Card.

See Your Act Contacts Geographically

MapLinx-for-Act merges digital mapping technology with the Act PC contact-tracking database to display your contact data geographically. The add-on software lets you search for contacts on your map and then import that contact information to Act, where you can use the data to do such things as form proposals and compile totals. MapLinx uses ZIP codes to view and select contact regions.
Price: Without ZIP code boundaries, $99; with boundaries, $399.
Contact: MapLinx Corp., 801 Presidential Dr., Richardson, TX 75081, (214) 231-1400; fax (214) 783-9072.
Circle 1304 on Inquiry Card.

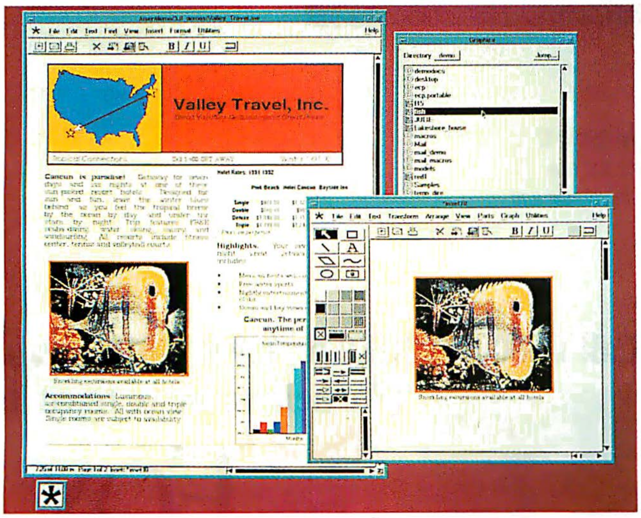


MapLinx's color mapping capabilities let you associate particular shades with contact, sales, or other information.

Unix Graphics, Mail, and More

With release 2.0, the Aster*x office integration system offers improvements to its GUI and word processing, graphics, spreadsheet, and mail capabilities. The program runs on eight Unix platforms.

Aster*x's tool bar lets you access program functions and user-defined macros. Word processing tools provide 16 foreign dictionaries and eight thesauri, and you can merge live foreign text into an Aster*x document. The program's graphics capabilities include support for rotating and scaling text. The paint program comes with a 125-color palette and tools such as fill, brighten, and blend. Aster*x 2.0's built-in file formats include X bit-map, Windows bit-map, and Amiga IFF ILBM. The spreadsheet now lets you drag and drop column widths, highlight individual cells or cell groups, and search for text or numbers. The program adds 46 financial, math, string, and other functions to its collection of spreadsheet tools. Enhancements to Aster*x Mail include the ability to select preferred fax cover sheets, signatures, and mail format.
Price: $695 and up.
Contact: Applix, Inc., 112 Turnpike Rd., Westborough, MA 01581, (508) 870-0300; fax (508) 366-9313.
Circle 1305 on Inquiry Card.



*You can add audio attachments and video images to your Aster*x documents.*

Project Management with Motif GUI

Running in the HP-UX environment, AutoPlan offers graphical project management to users of HP 9000 workstations. AutoPlan lets you produce bar charts and histograms that illustrate project schedules, resources, costs, and relationships within your work. The program uses the Motif GUI and features full WYSIWYG.

AutoPlan is available as a stand-alone product or encapsulated in Digital Tools' SoftBench software development environment. AutoPlan is also available for Sun-3 and Sun-4 Sparcstations, the DECstation series, and IBM RISC System/6000 workstations.
Price: Node-lock version, $1495; floating-user version, $2995 per license.
Contact: Digital Tools, Inc., 18900 Stevens Creek Blvd., Cupertino, CA 95014, (408) 366-6920; fax (408) 446-2140.
Circle 1306 on Inquiry Card.

Forecast Like a Pro

Forecast Pro Batch uses univariate techniques such as exponential smoothing and simple moving average to forecast unlimited numbers of items automatically. FPB 1.1 develops exception reports, monitors for forecast bias, and offers an evaluation option, which lets you withhold data from the end of your series so that you can compare the forecasts to actual values.

You can import and export data between FPB and Lotus 1-2-3, ASCII files, or Structured Query Language databases. The company also offers a 500-item version of the program.
Price: Standard version, $3995; 500 version, $1995.
Contact: Business Forecast Systems, 68 Leonard St., Belmont, MA 02178, (617) 484-5050; fax (617) 484-9219.
Circle 1307 on Inquiry Card.

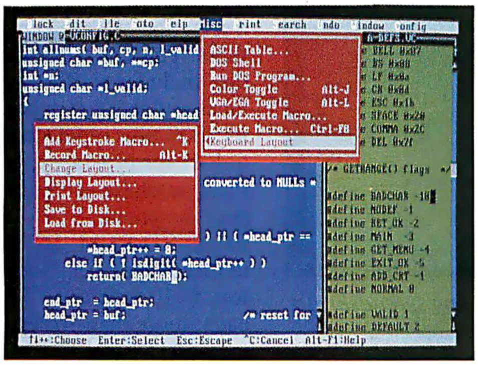
The new multi-mode VEDIT PLUS is the only text editor you will ever need!

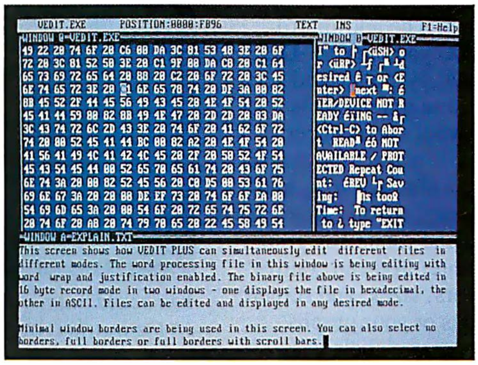
The most powerful text editor for program development and text processing

- **Drop-down menus, mouse support**
- **Columnar blocks, regular expressions, undo**
- **Also VEDIT for $69, VEDIT Jr. for $29**

The fastest text editor for mainframe, CD ROM and other huge files

- **Edit up to 2 Gigabyte text, binary, mainframe files**
- **Edit in ASCII, EBCDIC or Hexadecimal**
- **Emulate Wordstar, Word Perfect, Brief, vi, others**





The new VEDIT PLUS is today's finest programmer's editor. Small (80K) and lightning fast, it is written entirely in assembly language. VEDIT PLUS is the only programmer's editor that can edit *any* text or binary file you will ever encounter.

Incredibly, VEDIT is over 20 times faster than other editors on just a 3 megabyte file. When editing multi-megabyte files, only VEDIT has the speed to get the job done.

Benchmarks in 3 Meg File	VEDIT	Brief	Sage
Save and continue	52 sec	3:52 min	1:47 min
Load, modify, save, exit	21 sec	49 sec	1:38 min
Block-column copy (40x200)	2 sec	30 sec	2 sec
Delete one column in file	9:58 min	1:50 hour	1:03 hour
60,000 search & replace	3:18min	1:44 hour	1:32 hour

The extensive compiler support runs popular compilers and also your favorite linkers, debuggers and Make from within VEDIT. It even integrates tools from different vendors. When shelling to DOS, VEDIT swaps itself and TSRs out of memory, giving you as much as 620K of available memory for compiling the biggest programs. Only VEDIT gives you the advantages of a powerful editor with the convenience of an integrated environment.

VEDIT PLUS has every advanced feature you might expect. Simultaneously edit numerous files, split the screen into windows, search/replace with regular expressions. Automatic indent, block indent, parentheses matching and block operations by character, line, file or column speed program development. Word wrap, paragraph formatting, justification, centering and many printing options are ideal for text processing.

VEDIT PLUS has the most powerful macro programming language of any editor. It eliminates repetitive editing tasks and lets you create your own editing functions. It includes testing, branching, looping, user prompts, keyboard input, string and numeric variables, complete control over windows plus access to hardware interrupts, memory and I/O ports. Source level debugging helps you develop new macros quickly and easily.

Until now, few PC text editors could even begin to handle huge mainframe, CD ROM, postscript, plotter output and other multi-megabyte files. The new VEDIT PLUS, with its unique virtual memory management, handles them all effortlessly.

Edit in ASCII, EBCDIC or Hexadecimal modes, or split the screen for any combination of modes. File modes support DOS text, UNIX text, binary and many fixed length record formats.

VEDIT PLUS

DOS	QNX
XENIX	FlexOS
UNIX	IBM 4680

An intuitive user interface with drop down menus, hot keys, mouse support, optional scroll bars, context sensitive help, point and shoot file selection, 1000 level undo and unlimited keystroke macros make VEDIT PLUS easy to use, easy to learn. And it can emulate the keystrokes of almost any editor you already know.

Everything in VEDIT PLUS is configurable. The keyboard layout, the screen colors, the way control characters, long lines and window borders are displayed, and much more, is all configured with easy to use menus.

Confidently order your copy of VEDIT PLUS today; it comes with a 30 day money-back guarantee. VEDIT has been the choice of 100,000 programmers, writers and engineers since 1980.

VEDIT PLUS - DOS single user license: $185; DOS network 5 user license: $295; UNIX/XENIX, QNX, FlexOS/IBM 4680 single CPU license: $285. Site license pricing is available.

24-Hour Bulletin Board

A fully functional demo version of VEDIT PLUS and a shareware version of VEDIT Jr. are available on our BBS at 1-313-996-1304.

Toll Free: 1-800-45-VEDIT (1-800-458-3348)
Telephone: (313) 996-1300, Fax: (313) 996-1308
Mail: P.O. Box 1586, Ann Arbor, MI 48106

Greenview Data

Circle 39 on Inquiry Card.

Add Graphs to Spreadsheets

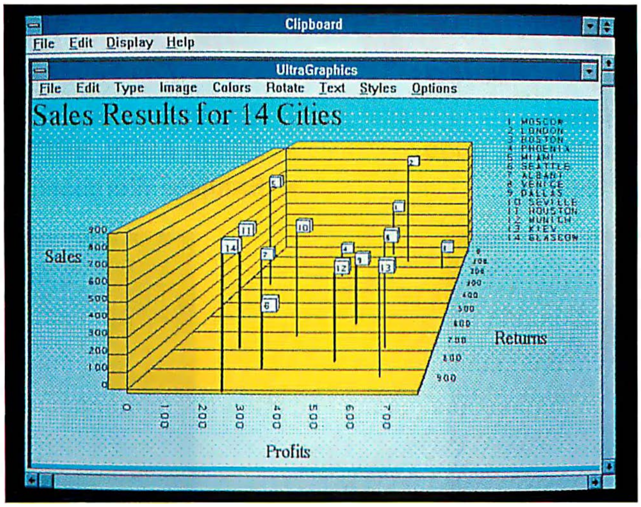
According to its developer, UltraGraphics lets users of most spreadsheets design sophisticated graphs and charts within their application. The add-in program lets you create 3-D bar, line, pyramid, and *x,y,z* graphs and other charts within your spreadsheet. Many UltraGraphics charts feature unlimited rows and value ranges. You can stretch and rotate any graph you create. You can control the colors, sizes, and screen positions of your graphs. The program labels your graphs automatically.

Intex claims that, in addition to being compatible with every major spreadsheet published in recent years, UltraGraphics lets you import graphs to word processing programs. The PC-based program supports PIC, PCX, and WMF file formats, among others.

Price: $245.

Contact: Intex Solutions, Inc., 35 Highland Cir., Needham, MA 02194, (617) 449-6222; fax (617) 444-2318.

Circle 1308 on Inquiry Card.



You could import this 3-D scatter graph into any spreadsheet on the market, according to Intex Solutions.

Multiple View Functions for Sun and Windows

The Windows version of AutoVue lets you view, print, plot, and manage CAD drawing files in such formats as AutoCAD DWG, HPGL, and Generic CADD. You can also view scanned raster files. AutoVue-Sun lets you view and print over a dozen file formats, and you can convert files from AutoVue's supported formats to DXF, HPGL, and other file formats.

Price: Windows version, $250; Sun version, $695.

Contact: Cimmetry Systems, Inc., 1430 Massachusetts Ave., Suite 306, Cambridge, MA 02138, (800) 361-1904 or (514) 735-3219; fax (514) 735-6440.

Circle 1309 on Inquiry Card.

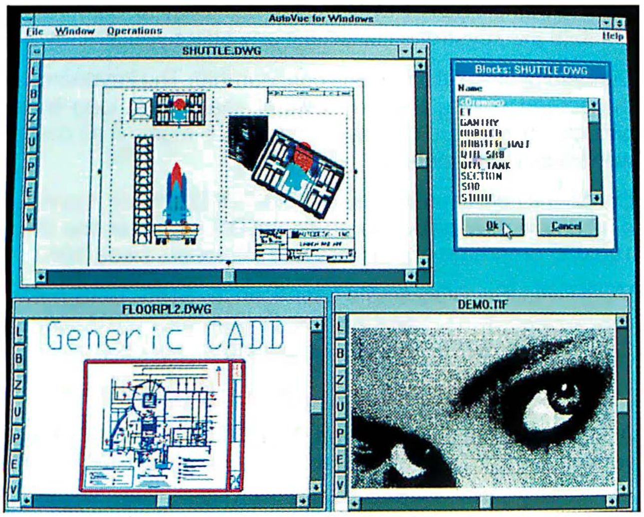
Capture Your Windows Screens

The latest incarnation of Pizazz Plus features a Windows screen-capture function, which you can use to save full-screen or selected Windows. Pizazz Plus 3.0 also features conversion capabilities for more than 20 graphics file formats, including PCX and TIF. You can print your Pizazz Plus images on over 400 printers, including the Hewlett-Packard DeskJet 500C.

Price: $149.

Contact: Application Techniques, Inc., 10 Lomar Park Dr., Pepperell, MA 01463, (508) 433-5201; fax (508) 433-8466.

Circle 1310 on Inquiry Card.



AutoVue lets you open as many windows as your memory will allow.

Typeface Library on CD-ROM

The CD-ROM version of Bitstream's Typeface Library for the Macintosh is available in PostScript Type 1 format and includes a selection of TrueType fonts. The Type Treasury disc includes six free typefaces and lets you preview its 1000-plus typefaces. To unlock the typefaces, you must purchase access codes over the phone.

Price: CD-ROM, $69; up to three typefaces, $49 each; four to 10 typefaces, $40 each; more than 10 typefaces, $35 each.

Contact: Bitstream, Inc., 215 First St., Cambridge, MA 02142, (617) 497-6222; fax (617) 868-4732.

Circle 1311 on Inquiry Card.

Turn Documents into Perfect Presentations

Perfect Presentations 2.0 lets you create charts and graphs from within WordPerfect 5.1. You can use the Desmond International add-in to design pie, bar, line, area, and scatter graphs within your WordPerfect documents. Perfect Presentations imports data from Lotus 1-2-3 worksheet files for direct integration within your presentation. Perfect Presentations works with the DOS version of WordPerfect 5.1.

Price: $95.

Contact: Desmond International, Inc., 99 High St., Suite 3001, Boston, MA 02110, (617) 338-9650; fax (617) 338-2752.

Circle 1312 on Inquiry Card.

BEFORE YOU KNOW IT, THERE'LL BE A PORTABLE COMPUTER THAT'S ACTUALLY BETTER THAN A DESKTOP.

SEE WHAT WE MEAN?

You've dreamed about a computer like this.

One that would have power and display capabilities equal to, or greater than, the desktop computer you're using now.

One you could take along to all of those different places you need to work.

One you wouldn't need a furniture dolly to move.

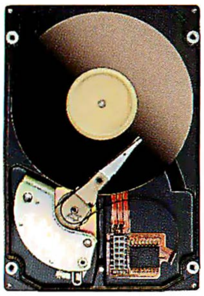
And here it is.

The Toshiba T6400.

With dimensions of 15.4″ W x 10.5″ D x 3.3″ H (4.1″ H with the color screen), it's small enough to fit in a briefcase.

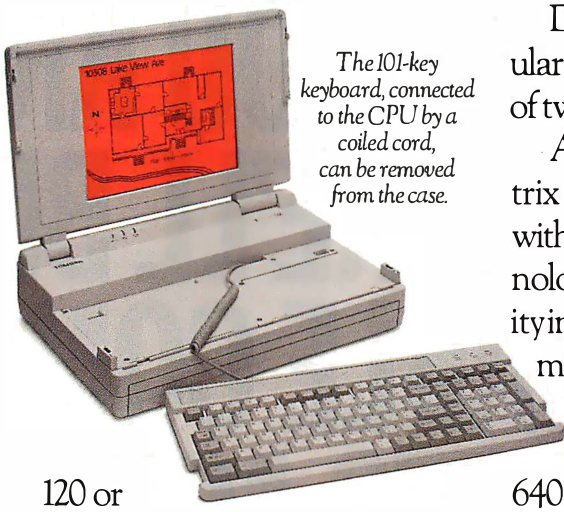
With a spirited clock speed of 33 MHz, a powerful 486 DX microprocessor, 8K internal cache and full 32-bit architecture, it's big enough to handle all those jobs normally performed in an impressive office building.

In addition to a 1.44MB floppy drive, you can choose a 120 or 200MB hard disk.



And if a combination like that doesn't make the T6400 portable better than the desktop computer you're currently using, we'll eat our collective hat.

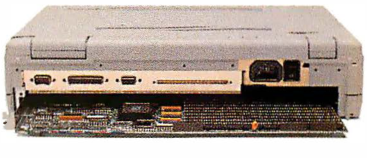
This remarkable machine comes equipped with an internal 1.44MB, 3½″ floppy drive and a 120 or 200MB hard disk. Plus 4MB RAM, expandable to 20MB. (Try finding any application that needs more memory than that.)



The 101-key keyboard, connected to the CPU by a coiled cord, can be removed from the case.

There's also a full-length, IBM-compatible, 16-bit expansion slot so you can take full advantage of your network card, SCSI controller or any of a myriad of other special purpose cards.

For even more expandability the T6400 comes complete with a 150-pin expansion port for direct input/output to the CPU, enabling you to connect storage and communications devices. Plus an internal dedicated modem slot, as well as built-in parallel, serial, mouse and Super VGA video ports.



The AC-powered T6400 has full desktop expandability, including an IBM-compatible, 16-bit expansion slot.

Depending on your particular needs, you can choose one of two display screens.

A state-of-the-art active matrix Super VGA color display with Thin Film Transistor technology, to deliver a higher quality image than you can get with most desktop monitors, and capable of displaying 256 simultaneous colors at 640 x 480 resolution.

Or a gas plasma display featuring 16 gray scales, also at 640 x 480 resolution, and a 100:1 contrast ratio—seven times the contrast of standard LCD displays, with ten times the display speed.

Both have a diagonal measure of 10.4″ and provide simultaneous viewing capability with external Super VGA displays.



To complete the T6400's amazing metamorphosis from desktop to portable, we took a 101-key keyboard



with full-size keys and key spacing, separate numeric keypad and eight dedicated cursor control keys, and nestled it into a compact 11.7 lb. package (12.9 lbs. with color screen). Then attached it to the CPU with a coiled cord, so you can remove it and use it on your lap (or other convenient surface).

Now, having read all of the above, you'd probably welcome more information on the T6400. If so, call us at 1-800-457-7777.

The more you learn about our products the more you'll come to understand the Toshiba philosophy: that portables are the future of personal computing.

Of course, with the introduction of the T6400 portable, it's a future that's already here.

In Touch with Tomorrow
TOSHIBA

Dadisp 3.0 for Two New Platforms

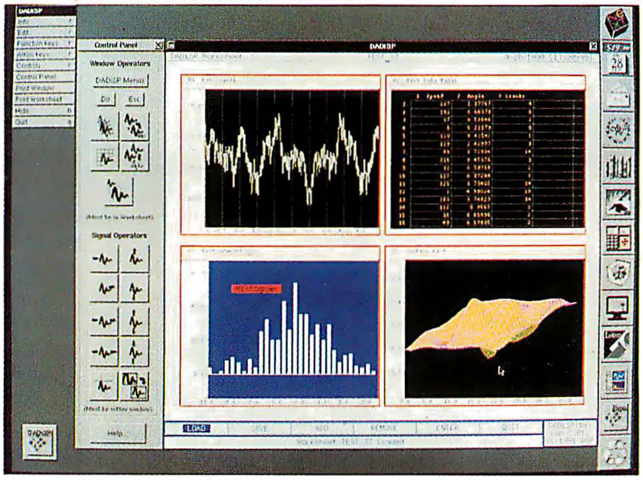
Dadisp now runs on the Next workstation and on Hewlett-Packard's HP Apollo 700 workstation. Version 3.0 of the scientific-data-analysis program performs mathematical problem solving, what-if speculation, graphical analysis of sampled information, conversion of data from graphical windows into numbers, and other analytical functions.

Dadisp performs data acquisition with A/D boards, and the program can exchange data with instruments using the IEEE-488 (Hewlett-Packard Interface Bus/general-purpose interface bus) protocol.

Price: Next version, $4495; HP Apollo 700 version, $895 to $6995.

Contact: DSP Development Corp., 1 Kendall Sq., Cambridge, MA 02139, (617) 577-1133; fax (617) 577-8211.

Circle 1313 on Inquiry Card.



Dadisp can be used for laboratory research, electronic testing, and physiological data analysis.

For Chico Solver, Math Is No Problem

Version 2.3 of Chico Solver can process unlimited numbers of equations within a system, according to the developer, and can run up to 100 times faster than its predecessor. The numerical-modeling software lets you build large equation systems that include multiple files containing function definitions, algebraic equations, or differential equations.

You can also automatically isolate and reorder separable equation sets, optimize any parameters used in equations or function definitions, and directly enter differential equations as a means of defining new functions. Chico Solver now provides such features as on-screen color controls, more detailed result and error messages, and graphics options that include scaling, labeling, and grid lines.

According to the company, Chico Solver has the ability to solve equation systems faster than larger mathematical programs such as MathCAD and Mathematica. Applications for Chico Solver include the design of systems within mechanical, chemical, automotive, and aerospace industries.

Price: $399.

Contact: Chico Software Co., P.O. Box 5174, Chico, CA 95927, (916) 342-3279; fax (916) 893-1050.

Circle 1314 on Inquiry Card.

A High-Speed Model Solver

Diffeq with Fitting, MicroMath's program for performing least-squares parameter estimation with differential equations, saves you time in experimentation and verification, according to the developer. The product provides goodness-of-fit statistics and on-line graphics to show whether or not your results are satisfactory.

Diffeq with Fitting offers eight methods of solving models and four plotting styles. Least-squares parameter estimation methods include Powell's method and optional prefitting simplex method.

You can import and export data between Diffeq and Lotus 1-2-3, dBase, ASCII, and other data files. The program provides a plot editor with axis control, eight fonts, and drawing tools. You are able to export your charts to other applications via PCX, TIF, WPG, and other file filters.

Price: $395.

Contact: MicroMath Scientific Software, P.O. Box 21550, Salt Lake City, UT 84121, (801) 943-0290; fax (801) 943-0299.

Circle 1315 on Inquiry Card.

Analyze Data from Different Platforms

Cross-platform data analysis and reporting are now available for users of Windows, Unix, or Macintosh systems. CrossTarget (formerly called Power Search and available only for the Mac) lets you merge corporate data from disparate databases and platforms, transform it into a graph or spreadsheet-style chart, and analyze it.

You can use CrossTarget to merge and analyze up to 1 million records, including sales, statistical, and personnel information, from relational and nonrelational databases.

You can purchase the program's three modules individually or as a group. Builder compresses, indexes, and stores data; Data Integrator merges database information for transformation by Builder; and the Diver tool lets you spontaneously examine trends and leads throughout your data.

Price: Stand-alone versions, $1000 to $8000; per client/server station, $1500 to $4500.

Contact: Dimensional Insight, Inc., 99 South Bedford St., Burlington, MA 01803, (617) 229-9111; fax (617) 229-9113.

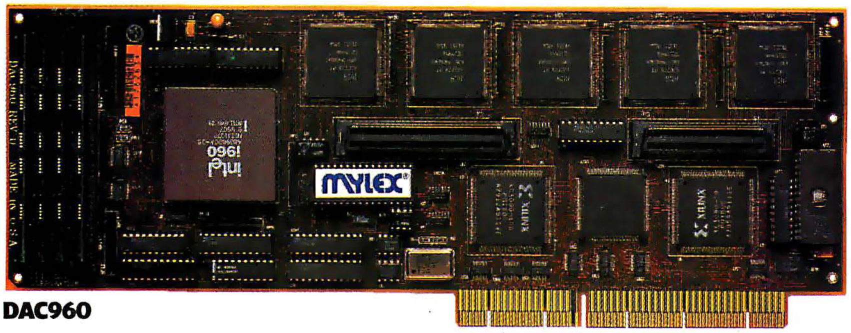
Circle 1316 on Inquiry Card.

SPREAD THE WORD

Please address new product information to New Products Editors, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458. Better yet, use your modem and mail new product information to the microbytes.hw or microbytes.sw conferences on BIX. Please send the product description, price, ship date, and an address and telephone number where readers can get more information.

SCSI Host Adapters

NEW

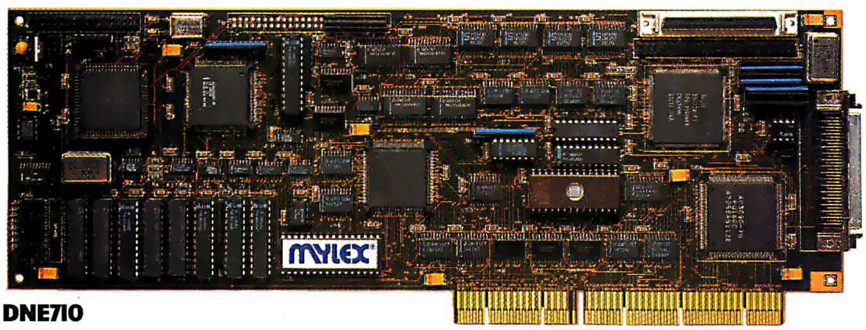


DAC960

EISA Multi-Channel SCSI-2 Host Adapter* (Available to OEMs only)

- Five SCSI-2 (fast and wide) channels– each channel supports up to 20 MB/s peak throughput
- Intel i960CA RISC processor; up to 64MB of write-back cache
- Striping with built-in support for various RAID levels
- Disconnect/reconnect, scatter/gather, command queuing, duplexing, mirroring and spanning
- Fault tolerance features include automatic drive failure detection, hot replacement and transparent rebuild

NEW



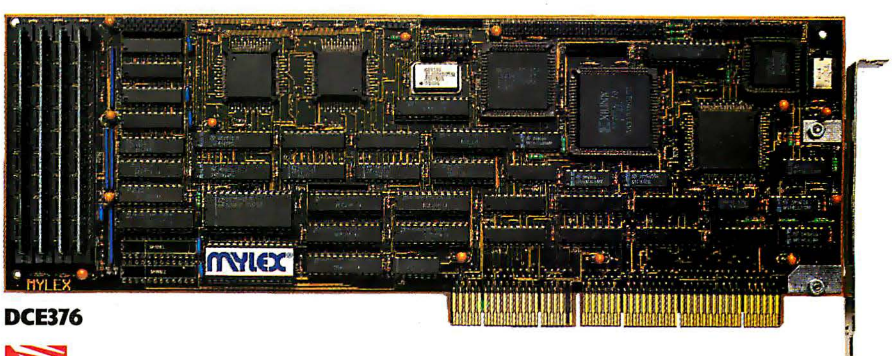
DNE710

EISA SCSI-2 Host Adapter**

- Fast SCSI-2 providing 10MB/s peak throughput
- EISA bus-master transfer rates up to 33MB/s
- Support for all popular SCSI devices
- Disconnect/reconnect, scatter/gather, synchronous drive support, duplexing and mirroring
- DOS, OS/2, Unix, NetWare

EISA SCSI Host Adapter

- Intel 80376; up to 8MB cache
- EISA bus-master transfer rate up to 33MB/s
- Disconnect/reconnect, scatter/gather, mirroring, duplexing and tape backup
- DOS, OS/2, UNIX, SCO UNIX, NetWare, Windows 3.0



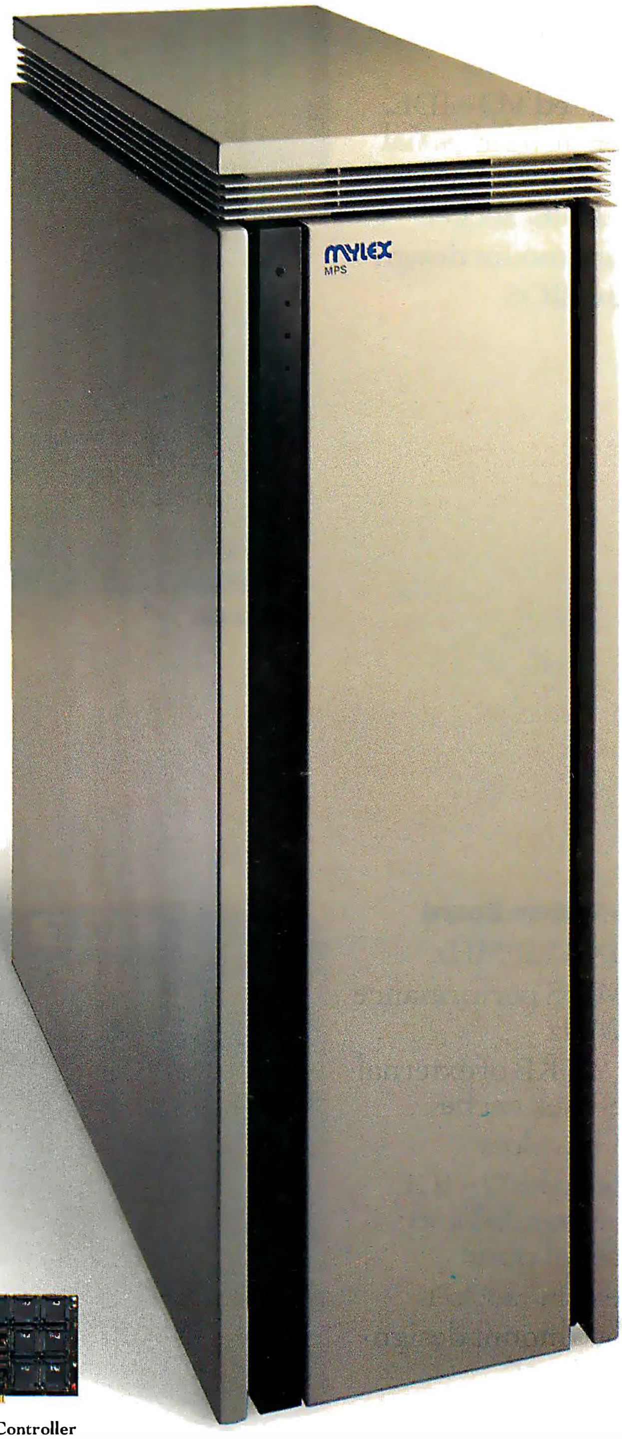
DCE376

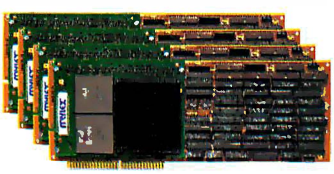
Novell Labs Tested & Approved™

Multiprocessing System

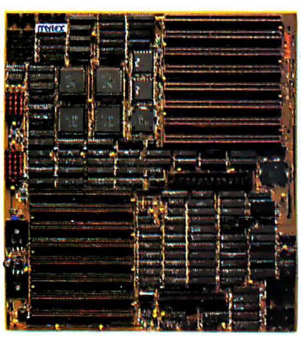
- 64-bit 267MB/s fully symmetric multiprocessing bus
- Four 486 50MHz CPUs with up to 512KB write-back cache
- EISA bus for high-performance I/O
- Up to 512MB of ECC memory
- Fully scalable and field upgradable
- All EISA peripherals available from Mylex; Mylex BIOS
- UNIX V.4, Novell NetWare 286/386, SCO MPX, MS-DOS, Windows 3.0 and LAN Manager supported

Available Q2, 1992

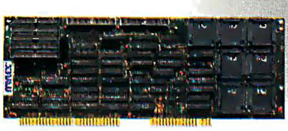




CPU Board



EISA Bus Interface Backplane



Multiprocessor Interrupt Controller

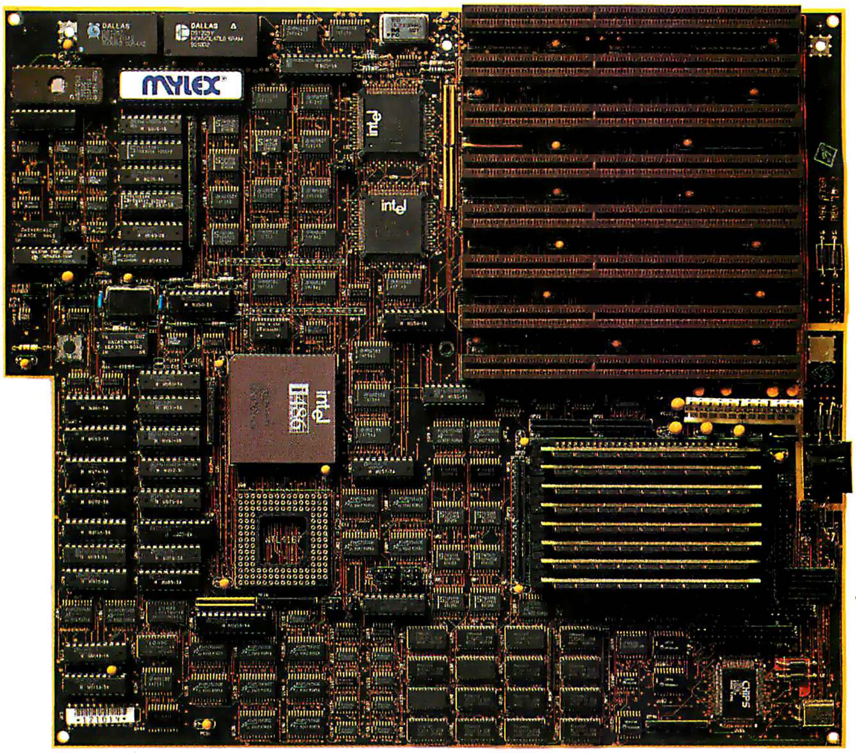


ECC Memory Controller

System Boards

EISA 486 System Board

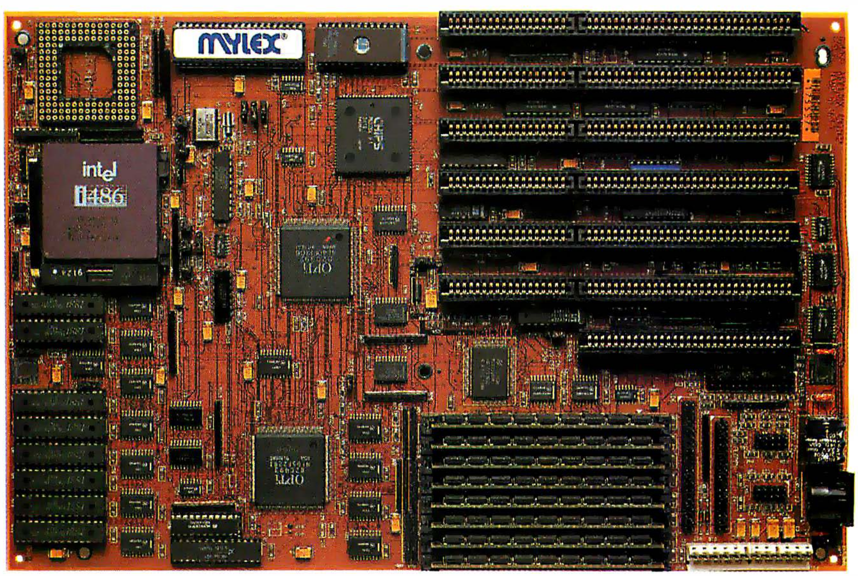
- 486DX 33/50MHz
- 14.5 MIPS performance
- 128KB of external write-back cache
- 8 EISA bus slots
- Integrated I/O– IDE, floppy, parallel, serial and PS2 mouse ports
- Weitek 4167 socket
- Surface mount design
- Mylex BIOS



MNE486

ISA 486 System Board

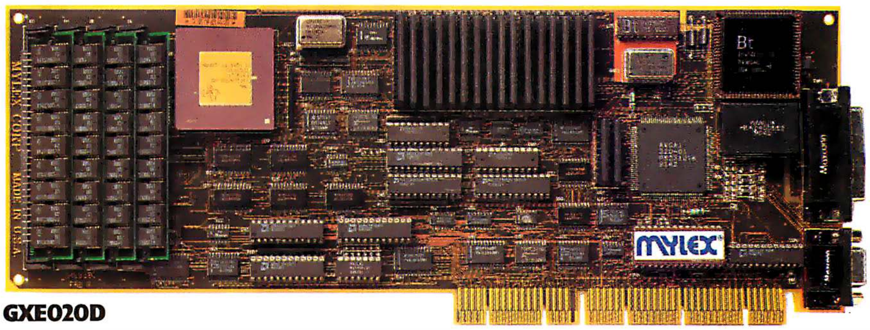
- 486DX 33/50MHz
- 14.9 MIPS performance at 33MHz
- 64 or 256KB of external write-back cache
- 7 ISA bus slots
- On-board I/O– IDE, floppy, parallel and two serial ports
- Weitek 4167 socket
- Surface mount design
- Mylex BIOS



MDI486

* Available March, 1992
** Available Q2, 1992

Graphics Controllers

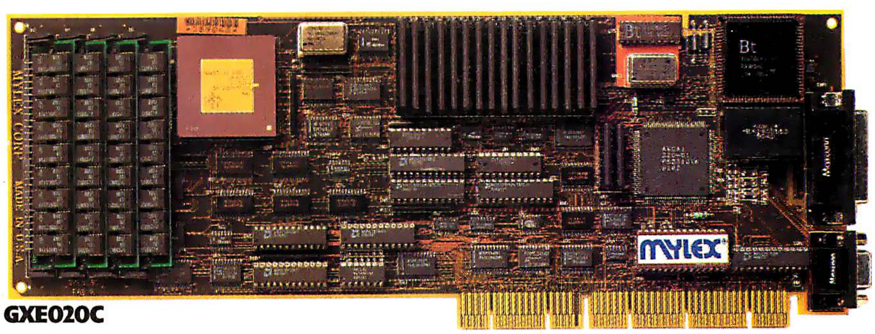


GXE020D

NEW

EISA Graphics Controller**

- TI34020 40MHz graphics processor
- 1600 x 1200 non-interlaced resolution
- 8 bit-planes for 256 simultaneous colors
- TIGA 2.05 compatibility
- VGA on-board
- Drivers for AutoCAD, X-Window and Windows 3.0

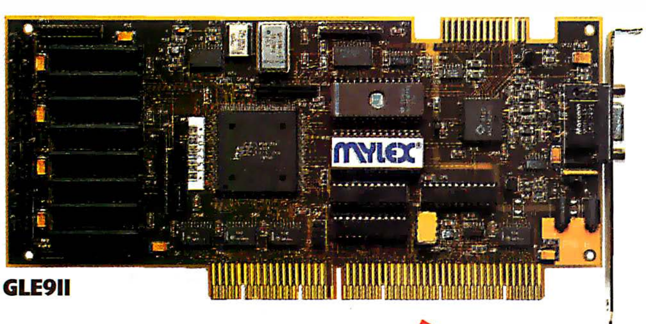


GXE020C

NEW

EISA Graphics Controller

- TI34020 32MHz graphics processor
- 1280 x 1024 non-interlaced resolution
- 8 bit-planes for 256 simultaneous colors
- TIGA 2.05 compatibility
- VGA on-board*
- Drivers for AutoCAD, X-Window and Windows 3.0

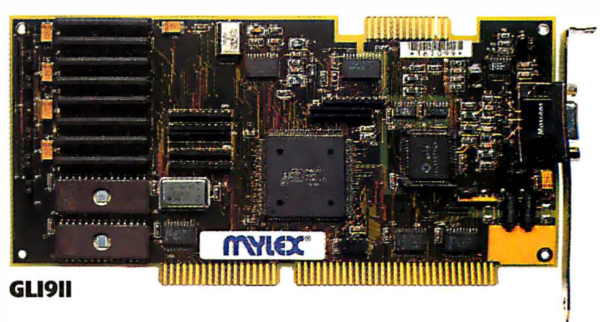


GLE9II

NEW

EISA Graphics Accelerator**

- S3 graphics accelerator
- EISA bus data transfers
- 1280 x 960 x 16 or 1024 x 768 x 256 resolution
- 100% VGA compatible
- Drivers for Windows 3.0, GEM 3.1, Ventura, AutoCAD and many more



GLI9II

ISA Graphics Accelerator

- S3 graphics accelerator
- ISA bus data transfers
- 1024 x 768 x 256 resolution
- 100% VGA compatible
- Drivers for Windows 3.0, GEM 3.1, Ventura, AutoCAD and many more

Disk Array Subsystem



- ▸ Fastest disk array subsystem on the market– includes disk array enclosure, controller, host adapter and software
- ▸ Five SCSI-2 (fast and wide) channels– each channel supports up to 20MB/s peak throughput
- ▸ EISA host adapter uses Intel i960CA 32-bit RISC processor
- ▸ Up to 64MB of write-back cache
- ▸ Modular support for single-ended or differential SCSI channels
- ▸ Flash EPROMs for easy firmware field upgrades
- ▸ Striping with built-in support for various RAID levels
- ▸ Disconnect/reconnect with full multi-threading, scatter/gather, command queuing, duplexing, mirroring and spanning
- ▸ Fault tolerance features include automatic drive failure detection, hot replacement and transparent rebuild

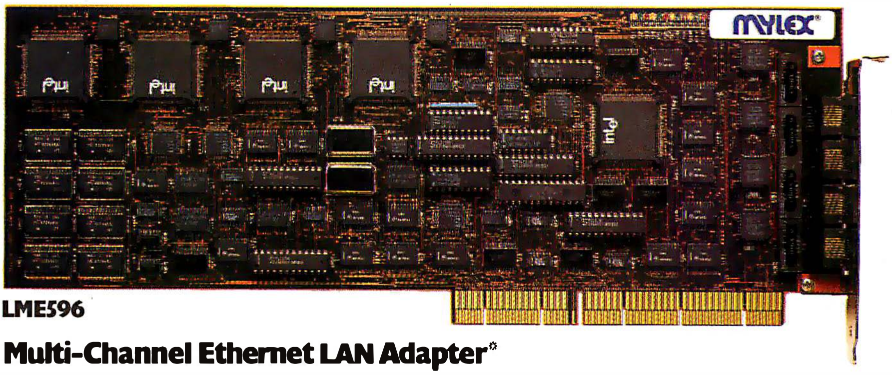
Available March, 1992



DAC960 Host Adapter

Ethernet LAN Adapters

NEW



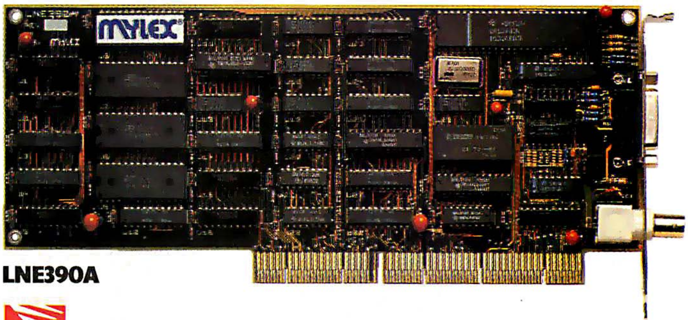
LME596

Multi-Channel Ethernet LAN Adapter*

- Four 10Base-T Ethernet ports
- Four Intel 82596 32-bit Network Interface Controllers (NIC)
- 256KB dual-ported SRAM (64KB per NIC)
- Intel 82355 EISA bus-master interface controller
- Up to 16 ports per host with four LME596 adapters
- Supports Novell NetWare 3.11, UNIX TCP/IP and NDIS

EISA Ethernet LAN Adapter

- DP8390 Network Interface Controller
- EISA shared-memory transfer rates up to 16MB/s
- Support for both thick- and thin-Ethernet interfaces
- Novell certified
- Supports Novell NetWare 2.15, 2.2, 3.0, 3.1 and 3.11, UNIX TCP/IP and NDIS

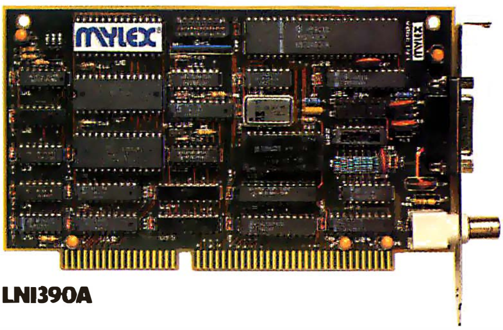


LNE390A

Novell Labs Tested & Approved™

ISA Ethernet LAN Adapter

- DP8390 Network Interface Controller
- Shared-memory transfer rates up to 2MB/s
- Support for both thick- and thin-Ethernet interfaces
- Supports Novell NetWare 2.15, 3.0, and 3.1 and UNIX



LNI390A

Develop 32-bit Windows Applications

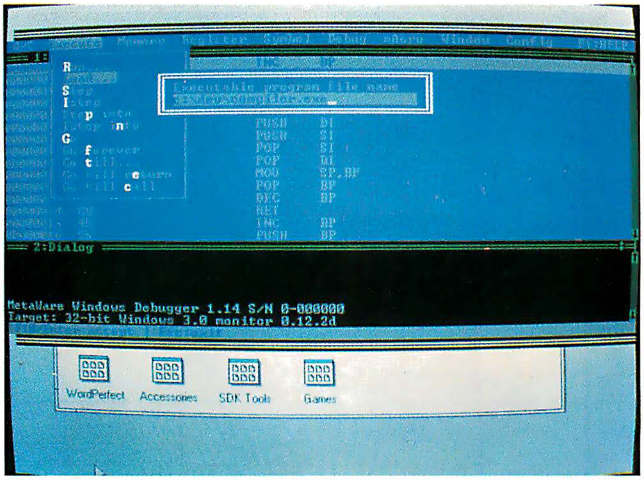
The MetaWare Windows Application Development Kit lets you develop, debug, and run true 32-bit Windows applications. The ADK provides binder and make utilities, a 32-bit dynamic-link-library supervisor, MetaWare's Windows Supervisor, a debugger, a memory-configuration utility, and 32-bit libraries and header files. MetaWare reports that you can port 16-bit Windows applications without using a DOS extender.

The kit's user interface includes on-line help, resizable windows, scroll bars, pop-up and pull-down menus, a source window, and a control window. In addition to MetaWare's High C compiler, the ADK requires the Microsoft Windows Software Development Kit for application development.

Price: $495; with High C compiler and source-level debugger, $1095 and up.

Contact: MetaWare, Inc., 2161 Delaware Ave., Santa Cruz, CA 95060, (408) 429-6382; fax (408) 429-9273.

Circle 1003 on Inquiry Card.



According to MetaWare, you can use its debugger to debug 32-bit applications on your development machine without using an extra terminal or computer.

Develop and Port CAD Programs

Easier and less-expensive development of Windows-based CAD applications is the goal of CADvance 5.0. The program's CADvance Development Interface (CDI) lets you access the CADvance PC-CAD graphics and database routines as Windows dynamic link libraries. Once you develop your applications in the CADvance for Windows environment, you can port them to other Windows-based CAD platforms.

According to the developer, outside applications written in a standard Windows-supported language run with CADvance. The development tool can handle scanned images and vector information for linking with raster-based applications. CADvance's Visual Programming facility lets you build subroutines that call more complex CDI programs and generate CDI code. CADvance supports Windows' Object Linking and Embedding and Dynamic Data Exchange capabilities, and it provides two-way database links using standard database-file and Structured Query Language conventions.

CADvance 5.0 requires Borland's Quick C for Windows programming language.

Price: $995.

Contact: ISICAD, Inc., 1920 West Corporate Way, P.O. Box 61022, Anaheim, CA 92803, (714) 533-8910; fax (714) 533-8642.

Circle 1002 on Inquiry Card.

A Windows FORTRAN Compiler

Version 2.60 of FTN77 FORTRAN compilers for 386- and 486-based PCs features a host of improvements. Most notable is FTN77's compatibility with Windows; the compiler will run under Windows in enhanced mode. FTN77 now features make and touch utilities, and the new text-windowing routines let you create drop shadows, title windows, and other effects in graphics mode.

Price: 386 version, $1295; 486 version, $1525.

Contact: OTG Systems, Inc., Suite 300, Rts. 106 and 374, P.O. Box 239, Clifford, PA 18413, (717) 222-9100; fax (717) 222-9103.

Circle 1001 on Inquiry Card.

Edit Code Through Windows

Designed from its inception to run efficiently in the Windows environment, Codewright lets Windows programmers edit code files without switching to DOS. According to its developer, Codewright's performance equals, and sometimes excels, the performance of DOS-based editors.

The program provides standard program-editing features (e.g., unlimited file and line sizes, unlimited undo and redo of changes, and multiple file/multiple window editing). Codewright also lets you compile, line, and debug your target program without leaving the editor. You can select and display or hide portions of the file text, and Codewright lets you highlight parts of the file you're editing in user-specified color for easy detection.

You can configure Codewright to meet your own preferences. The program's .INI file lets you select settings each time you run the file. For workgroups, you can configure Codewright differently for specific people or projects.

Codewright includes keymaps for Common User Access–compliant and Brief-compatible operation. You can modify the keymaps provided, or you can assign your own.

Price: $249.

Contact: Premia Corp., 1075 Northwest Murray Blvd., Suite 268, Portland, OR 97229, (800) 547-9902 or (503) 647-9902; fax (503) 647-5423.

Circle 1000 on Inquiry Card.

MacDraft: Not Just for Macs Anymore

Nearly identical to its Macintosh counterpart, MacDraft for Windows provides mainstream drawing and drafting tools with a focus on ease of use. The program is geared toward technical users who want to focus on their design without having to learn a great deal about how the software works.

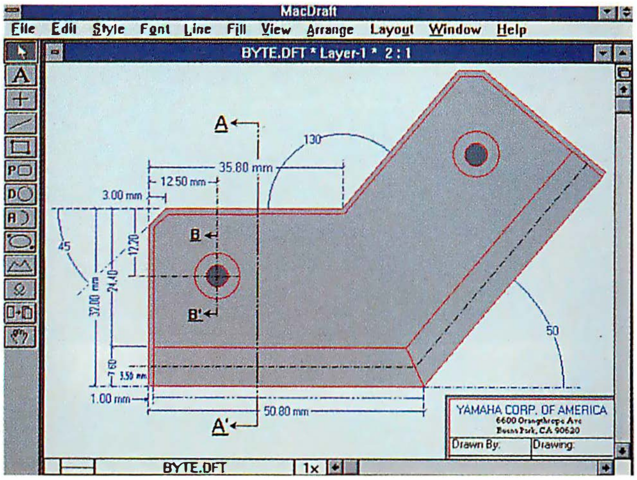
When drawing in MacDraft for Windows, your first task is to set a scale in either metric or English measurement units. Once you've defined your scale, the program keeps track of all component measurements, including angles, and lets you display line measurements at the line or in a legend. You can use the program's layering capabilities to create drawings in different scales and merge the layers to show areas of detail. Other drawing features include support for Bézier curves and splines, and you can create elliptical arcs with two keystrokes. You can also create and place circles in relation to three known points of intersection.

According to the developer, you can transfer your MacDraft files between Mac and Windows operating systems.

Price: $495.

Contact: Innovative Data Design, Inc., 2280A Bates Ave., Suite A, Concord, CA 94520, (510) 680-6818; fax (510) 680-1165.

Circle 1004 on Inquiry Card.



As you alter your MacDraft for Windows drawings, the program updates the dimension lines, area volumes, and angle measurements.

Analyze Your Equipment's Reliability

The ECP Enhanced Component Stress Analysis program, an add-on to Powertronic's Reliability Prediction program, analyzes electronic, electrical, and electromechanical products in accordance with requirements outlined in NASA, Air Force, Naval Air Force, and Department of Defense documentation. ECP lets you lower the levels of acceptable equipment stress to improve reliability. You might perform this reduction process, known as *derating*, to establish different equipment-reliability requirements in different situations.

You can generate reports that include your equipment data and calculations (e.g., derated stress or temperature, worst-case stress, and minimum rating required). ECP features pull-down menus and context-sensitive help. You must use the Reliability Prediction program in conjunction with ECP.

Price: $1000.

Contact: Powertronic Systems, Inc., P.O. Box 29109, New Orleans, LA 70189, (504) 254-0383; fax (504) 254-0393.

Circle 1006 on Inquiry Card.

ISICAD: Now in a Window near You

The release of ISICAD's CADvance for Windows brings you a design product rich in information-sharing tools. CADvance merges Windows features (e.g., Dynamic Data Exchange and Object Linking and Embedding) with the program's new open development architecture, which records activities such as drawing functions and automatically generates compilable code.

CADvance supports bitmap and scanned images, and it lets you combine raster and vector information within a single drawing. According to ISICAD, the Windows version of the program retains speeds equal to those of DOS-based CAD packages.

Price: $3495.

Contact: ISICAD, Inc., 1920 West Corporate Way, P.O. Box 61022, Anaheim, CA 92803, (714) 533-8910; fax (714) 533-8642.

Circle 1005 on Inquiry Card.

Draw Contour Maps from Data Points

With Landview, you can turn 3-D coordinates into contour maps with as few as two commands. The Macintosh program uses the triangulated-irregular-network method of linearly interpolating imported data points into contour lines. You can import data from Landesign spreadsheet and other ASCII-based CAD programs and use that data as coordinate information. Once you've designed a contour map, you can export it as a PICT file for use in CAD applications.

Landview lets you control contour intervals and multiples and the base and highest contour values. You can display point and line labels with Northing, Easting, and elevation (x, y, z) orientation. Landview includes a zoom function, and it supports System 7.0 Balloon Help. According to its developer, future versions of the program will support volume calculations and terrain modeling.

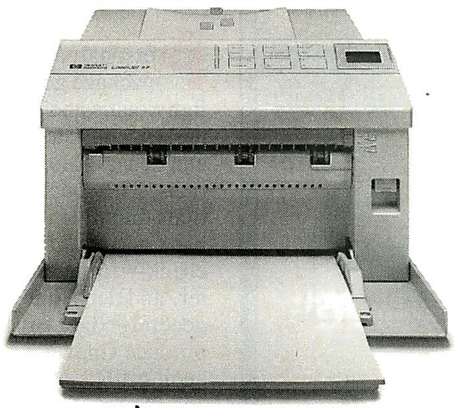
Price: $195 and up, depending on the configuration.

Contact: Compuneering, Inc., 113 McCabe Crescent, Thornhill, Ontario, Canada L4J 2S6, (416) 738-4601; fax (416) 738-5207.

Circle 1007 on Inquiry Card.

Just OK. Okidata OK!™

HP LaserJet® IIP+



$1249

Printhead warranty: 1 year
Conventional laser printhead
14 fonts, 2 typefaces
70-sheet paper tray
Curved paper path
Height: 8¼"

Okidata OL400



$999

Printhead warranty: 5 years
Okidata-built LED printhead (no moving parts)
17 fonts, 4 typefaces
Fully compatible with HP Series II software emulation
200-sheet paper tray
Straight-line paper path – feeds envelopes, labels, heavy stock without jamming
Low profile: 5 ½"

At $999 list, there's no lower priced page printer on the market than the Okidata OL400.* Yet it offers many features you won't find on the $1249 LaserJet IIP+.

Our solid-state LED printhead, for example, has no moving parts. It's so reliable, it comes with a 5-year warranty – longest in the industry (plus 1 year parts and labor on the printer itself).

Okidata's simpler printhead costs less to manufacture, and results in a simpler design overall – a major reason for the OL400's low cost. It also comes with more typefaces and fonts, and a high-capacity paper tray – all standard. And unlike the LaserJet, Okidata gives you your choice of parallel or serial interface.

And the OL400 has one more unique feature–the Okidata OK! It's our promise that every printer we sell will deliver not merely acceptable performance and good value, but outstanding performance and exceptional value.

So before you settle for a page printer that's merely OK, visit your authorized Okidata dealer and ask about the printer that's Okidata OK!–the Okidata OL400.

For further information, please call 1 (800) OKI-DATA.

OKI OK!
OKIDATA OK!™

We don't just design it to work. We design it to work wonders.™

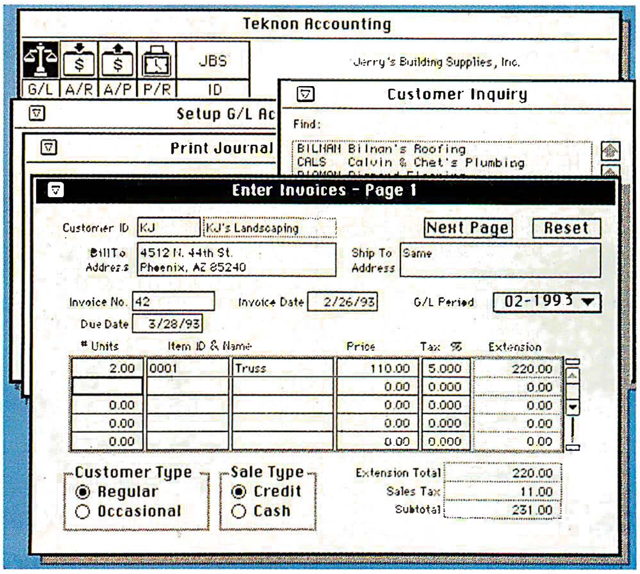
*Manufacturer's suggested retail price. Dealer prices may vary. HP and LaserJet are Reg. T.M. of the Hewlett Packard Corporation. P.C. Magazine, 6/12/90 issue. Okidata is a Reg. T.M. and Okidata OK! is a T.M. of OKI Electric Industry Co., LTD. "We don't just design it to work. We design it to work wonders" is a T.M. of OKI America Inc.

Circle 564 on Inquiry Card.

Mac-Like Accounting for DOS

The developer of the atOnce accounting package for Macintosh systems now offers a DOS version of that program. Teknon Accounting, nearly identical to its Mac counterpart, features a graphical Open Look/Mac windowed interface.

Teknon Accounting provides general-ledger, accounts-receivable, accounts-payable, custom-financial-report, custom-form, budgeting, billing, and payroll modules. As you enter data into one module, all modules are updated instantly. You can work with an unlimited number of accounts, transactions, customers, and employees.



Teknon Accounting's interface matches its Mac counterpart's.

Price: $149.
Contact: Teknon Corp., 8603 East Royal Palm Rd., Scottsdale, AZ 85258, (800) 899-0876 or (602) 596-1500; fax (602) 483-8293.
Circle 1024 on Inquiry Card.

MIS Offers New Product for DOS

Personal, an accounting package geared toward individuals and small businesses, consists of checkbook and general-ledger functions. The checkbook functions maintain unlimited bank accounts and provide check-writing, check-register, and deposit tools. The general-ledger functions produce financial statements, audit trails, and journals, and they perform automatic updating of account data.

Price: $29.95.
Contact: Management Information Software, Inc., 3301 Gandy Blvd., Tampa, FL 33611, (813) 832-3449; fax (813) 831-1311.
Circle 1023 on Inquiry Card.

Circle 565 on Inquiry Card.



486/33 Features

80486 33MHZ 32 bit INTEL CPU
4MB RAM-Expandable to 32MB
Phoenix BIOS, 256K Static RAM Cache
8 Expansion Slots (ISA 16 bit)
14" SuperVGA Color Monitor, 1024x768, .28mm dot
1MB VGA Card, resolves 1024x768 at 256 colors
1.2 and 1.44 MB Floppy Disk Drives
120MB IDE Hard Drive, 19ms
Desktop Style Case (Tower Option Available)
220W Switching Power Supply
Serial, Parallel, and Game Ports
MS-DOS 5.0, Serial Mouse included
Full 1 Year Limited Warranty-Parts and Labor

EISA System, 32 bit Bus (EISA has 7 32-bit slots, 1 16-bit slot)	add $750	200MB IDE (19ms)	add $250
Non-Interlaced Video (.28 dot)	add $90	336MB ESDI (16ms)	add $1150
Sony 1304 (NI at .25 dot)	add $450	760MB ESDI (14ms)	add $1950
		ESDI/EISA 32-bit Controller	add $795



SHOPPER'S ADVISORY– If you're finding yourself stuck in the confusing forest of computer dealers, you won't find many that can claim: *1) A Large National Customer Base, 2) Major Corporate Clients, 3) Retail/ Mail Order and Wholesale business, 4) An Established Tradition of Customer Support.* But WE CAN! Since 1984, we continue our commitment to providing the highest quality components and service at the best price.

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386SX/25 SuperVGA

105MB Hard Drive, 2MB RAM, SVGA, Dual Floppy

80386SX 25MHz CPU
2MB RAM-Expandable to 16MB
14" SuperVGA Color Monitor, .28mm dot
512K Super VGA Card
1.2MB and 1.44MB Floppy Disk Drives
105MB IDE Hard Drive, 19ms
Desktop Style Case, 101 Keyboard
220W Switching Power Supply
Serial, Parallel, and Game Ports
Full 1 Year Limited Warranty-Parts and Labor

$1295.00

286 and 386 SX

42MB Hard Drive, 1MB RAM, Mono Monitor

1MB RAM-Exp. to 4MB(286) or 8MB(SX)
12" Monochrome TTL Monitor, 720x348 res.
MonoGraphic Card, Hercules Compatible
1.2MB Floppy Disk Drive
42MB IDE Hard Drive, 28ms
Desktop Style Case, 220W Switching PS
Serial, Parallel, and Game Ports
Full 1 Year Limited Warranty-Parts and Labor

386SX/20 **$845.00**
286/12 **$645.00**
386SX/16 **$795.00**

14" SuperVGA, 512K VRAM	add $350
80MB Hard Drive, 19ms	add $100
120MB Hard Drive, 19ms	add $200
Memory Upgrade (per MB)	add $65

386/33 Power System

120MB Hard Drive, 4MB RAM, SuperVGA

80386 33MHZ 32 bit CPU
4MB RAM-Expandable to 32MB
128K High Speed Static RAM Cache
14" SuperVGA Color Monitor, 1024x768 (.28 dot)
1MB Super VGA Card, 1024x768 at 256 colors
1.2 and 1.44 MB Floppy Disk Drives
120MB IDE Hard Drive, 19ms
Desktop Style Case
220W Switching Power Supply
Serial, Parallel, and Game Ports
MS-DOS 5.0, Serial Mouse included
Full 1 Year Limited Warranty-Parts/Labor

Price Includes Shipping in Continental U.S. **$1795.00**

Non-Interlaced SVGA, .25mm dot (Sony tube)	add $350
17" Non-Interlaced SVGA, .28mm dot	CALL
20" Non-Interlaced SVGA	CALL

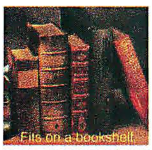
Logitech Mouse and Windows 3.0 only **$75** with System



New! from MICRONICS COMPUTERS INC.

Mpact **386SX/20** Notebook Computer

$1750.00



- ❑ Compact 10"x12"x2", 7 pounds
- ❑ 60MB Hard Drive, 19ms access time
- ❑ 1MB RAM, expandable to 5MB
- ❑ 10" VGA LCD Display, 32 Grayscale
- ❑ 16Bit VGA, 512K Video RAM
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4151 Beltline Rd. #120 Addison, TX 75244 (214)702-8588	12110 Westheimer Houston, TX 77077 (713)497-7887	17338 Southcenter Pkwy. Tukwila, WA 98188 (206)575-9060	GREATER ATLANTA 5939 Jimmy Carter Blvd. Norcross, GA 30071 (404)416-9605

Circle 562 on Inquiry Card (RESELLERS: 563).

Share Mac and Windows Data with GQL

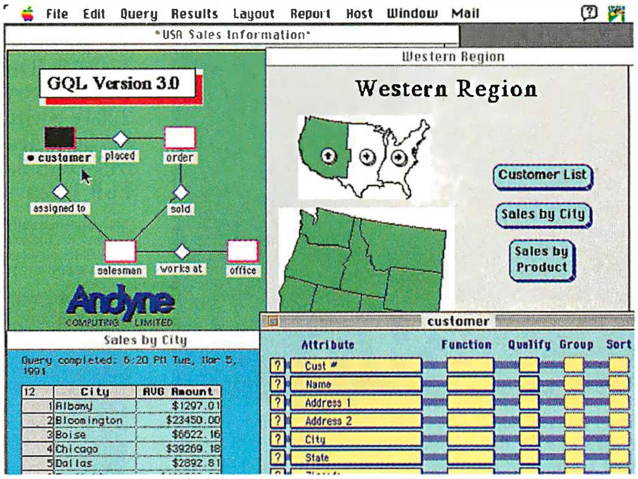
The Graphical Query Language line of ad-hoc Structured Query Language database query-and-reporting tools for Macintosh systems now branches out to Windows. You can develop your own data-analysis and reporting environments using the program's point-and-click WYSIWYG interface.

GQL for Windows lets Windows and Mac users share data from SQL databases. Optional administrative modules of GQL for Windows let select users develop query environments, perform data entry, and create new databases.

Price: User version, $350; administrative modules, $450 and up.

Contact: Andyne Computing, Ltd., 552 Princess St., Second Floor, Kingston, Ontario, Canada K7L 1C7, (613) 548-4355; fax (613) 548-7801.

Circle 1030 on Inquiry Card.



GQL lets you store frequently used queries as Executive Buttons, which let you access information with automatic report generation, charts, data analysis, and integration with other applications.

Novice and Pro Tools

DataEase Personal for DOS provides a menu-driven interface, the Query-By-Example reporting facility, and other functions for developing applications.

DataEase 4.5 lets professional users migrate applications to an on-line distributed database environment. Version 4.5 runs OS/2 and DOS, and it lets you add client-server access to multiple Structured Query Language database engines.

Price: DataEase Personal, $99; DataEase 4.5, $795; SQL Connect, $495.

Contact: DataEase International, Inc., 7 Cambridge Dr., Trumbull, CT 06611, (800) 243-5123 or (203) 374-8000; fax (203) 365-2317.

Circle 1029 on Inquiry Card.

Pro and Personal Versions of RapidTax for PC

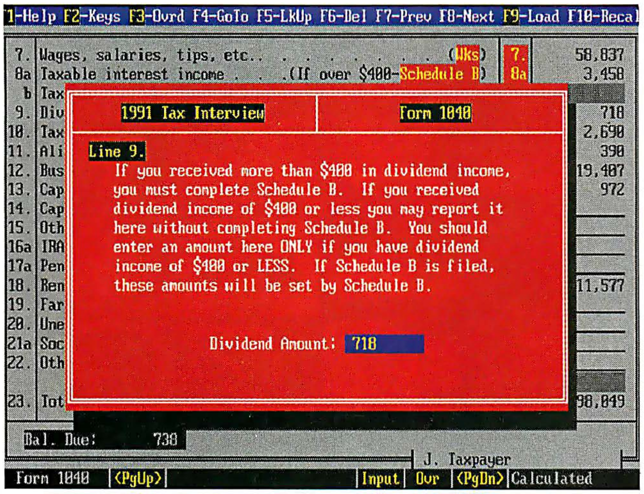
RapidTax Professional is geared to getting the professional accountant through tax season quickly and easily. You can load any form with a single keystroke and share data among forms, schedules, and state returns. RapidTax features a what-if form-filling capability; an auto-save feature; an audit detector; an on-line manual; and a client organizer, billing module, and checklist. You can receive RapidTax program updates and technical support via the included communication software and your modem. DacEasy offers electronic filing software, 23 state modules, and Refund Anticipation Loan software.

The personal version of RapidTax lets you choose between an interview style of data entry or a direct-form style of entry. The program offers time- and money-saving tax tips and a built-in tutorial. State modules are available from DacEasy.

Price: Professional version, $699.95; professional-version state modules, $199 each; personal version, $49.95; personal-version state modules, $29.95 each.

Contact: DacEasy, Inc., 17950 Preston Rd., Suite 800, Dallas, TX 75252, (800) 877-8088; fax (214) 248-1239.

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RapidTax Personal's interview approach walks you through your return step-by-step and steers you away from answering unnecessary questions.

Federal and State Preparation for the PC

The 1991 version of Personal Tax Edge lets you work on multiple tax forms simultaneously. The program's windowing capability lets you work on one form and switch among others as you wish. Tax Edge's cross-reference feature shows you the list of forms and subtotals that make up the total of a specific line item.

The DOS-based program is a two-part set that consists of planning and final-filing versions. State return modules are available for all states requiring returns except Hawaii.

Other features of Tax Edge include pull-down menus, a glossary of tax terms, enhanced on-line help, a comparison chart of U.S. averages, and alternative-filing comparison tools. The program provides instructions for the nearly 40 tax forms, and it prints your return in an IRS-approved format.

Price: Personal Tax Edge, $49; state modules, $49 each.

Contact: Parsons Technology, 1 Parsons Dr., P.O. Box 100, Hiawatha, IA 52233, (319) 395-9626; fax (319) 395-0217.

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EasyTax Offers Helpful Hints

EasyTax for 1991 includes all IRS-approved forms, worksheets, and schedules. EasyTax provides on-screen help that explains the tax return process and offers tips to lower your tax bill. You can print replications of IRS tax forms or take advantage of the electronic-filing option. The developer offers state filing modules for 24 states.

EasyTax lets you import data from Quicken, Lotus 1-2-3, and other programs. The form-linking feature updates data in worksheets, forms, and schedules as you change information in one area. You can do what-if projections to determine your best tax alternative, and the DOS-based package warns you if your return's content might spark an IRS audit.

Price: $79.95.

Contact: Timeworks, Inc., 625 Academy Dr., Northbrook, IL 60062, (708) 559-1300; fax (708) 559-1399.

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ChipSoft Offers a Bundle of Tax Packages

TurboTax, available for DOS and Windows, walks you through the preparation of your tax return in a question-and-answer process. The program features specialized help topics that advise you on the implications of personal issues or answer questions on income, payment, and expense categories.

You can import data from Quicken or any spreadsheet directly into TurboTax, according to the developer. This year's version of the program features enhanced depreciation capabilities, and you can automatically flow amortization amounts to the appropriate line of your return. TurboTax does a final review of your return, highlighting unusual itemized deductions, audit flags, and year-round tax deadlines.

MacInTax alerts you to changes in tax laws and to the program itself. The System 7.0–compliant package features automatic form, schedule, and worksheet linkage. A state version of TurboTax is available for all 44 states that have income taxes; MacInTax offers 15 state packages.

Price: TurboTax, $79.95; TurboTax for Windows and MacInTax, $99.95; TurboTax state modules, $49.95 each; Windows and Mac state modules, $69.95.

Contact: ChipSoft, Inc., 6330 Nancy Ridge Dr., Suite 103, San Diego, CA 92121, (619) 458-8722; fax (800) 755-1040.

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The CD Gallery: Facts, Music, and More

The CD Gallery, an NEC CD-ROM drive and seven CD-ROM software titles, is available for PC and Macintosh systems. In addition to the disk-reading hardware, both versions include interface software, speakers, and headphones.

Both PC and Mac disk sets include the New Grolier Electronic Encyclopedia and The Time Table of History. The PC version comes with such titles as The Time Magazine Almanac and National Geographic Mammals: A Multimedia Encyclopedia. Mac users get Warner New Media and Time magazine's Desert Storm.

Price: $699 to $1229, depending on the CD-ROM drive and the system interface.

Contact: NEC Technologies, Inc., 1255 Michael Dr., Wood Dale, IL 60191, (708) 860-9500.

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NEC's CD Gallery lets you access the Los Angeles visitors' guide, which is offered as part of the Great Cities of the World disk for PCs.

A Business Directory on a Disk

Nynex Fast Track, the consumer and business telephone directory, is now available as a nine-disk set that lets you access directory information by name, address, telephone number, or ZIP code for more than 77 million listings. You can purchase Fast Track in any number of regional combinations. The directory will be updated quarterly.

Price: $125 to $7995, depending on configuration.

Contact: Nynex Information Technologies Co., 100 Church St., Ninth Floor, New York, NY 10007, (800) 338-0646 or (212) 513-9735.

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7 ☐ Senior-level
8 ☐ Middle-level
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C. Are you a reseller (VAR, VAD, Dealer, Consultant)?

10 ☐ Yes
11 ☐ No

D. What operating systems are you currently using? (Check all that apply.)

12 ☐ PC/MS-DOS
13 ☐ DOS + Windows
14 ☐ OS/2
15 ☐ UNIX
16 ☐ MacOS
17 ☐ VAX/VMS

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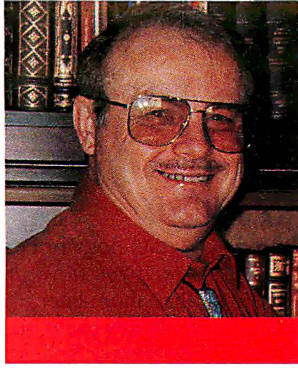
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JERRY POURNELLE

INTERRUPTS AND BIG CATS

Nietzsche says that which does not kill us makes us stronger. This month seemed designed to demonstrate that to me, but all's well that ends well....

My Cheetah 386/25 is one of the first ones they made. Indeed, I got it when 386 chips were rare, and I had to wheedle a 25-MHz 386/387 chip set out of Intel, since Cheetah couldn't get any for me. The system was assembled by Larry Aldridge, and it was my main system from the day I got it until a couple of weeks ago. During that time, it was turned off only when I went on trips and the innumerable times we changed one or another peripheral board.

We also loaded it up: CD-ROM drive, tape drive, LAN card, Perceptive Solutions drive controller with 4 MB of on-board cache memory, dual hard drives—you name it, and we put it in there. In all that time, I had no real problems with it; indeed, that machine was so reliable that although I have had a Cheetah Gold 486/33 for months, I continued to use the 386/25, relegating the 486 to the status of a network server.

Two weeks ago I set up Norton Commander to go look at my MCI Mail, and I went for a hike in the local hills. When I got back, the screen was blank, and there was no power light on the machine. I thought at first that the housekeeper had turned the machine off, but no, the switch was on. But the fan wasn't on, and the drives were not spinning.

This seemed odd. My writing machines are powered from a Clary uninterruptible power supply, and it was working just fine as always.

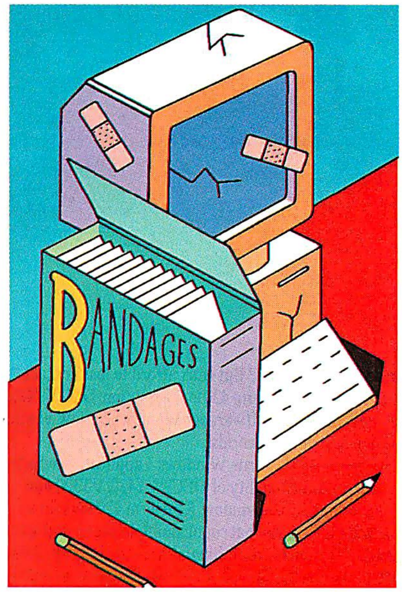
I flipped the power switch off and back on. The power light came on for about a second and went off again. No question about it, I had a problem. I opened up the machine and thought about it. My first thought was a short of some kind, possibly on one of the boards. First thing, then, was to pull out the drive controller board. With its 4 MB of memory, it uses more power than anything else. Sure enough, it made a difference: now, when I flipped the power switch, it stayed on for almost 2 seconds before going dead.

Next step was to unplug everything. When I did that, the power supply would run fine; but as soon as I put a load on it, it died. Not much question, then, that the problem was the power supply. I had a 200-watt Turbo-Cool power supply from PC Power & Cooling. In fact, all my Cheetah systems have Turbo-Cool power supplies; that was the only kind Larry Aldridge recommended. A quick call to my son Alex confirmed my theory.

Alex also pointed out that when we added all the peripherals and extra drives we'd loaded that 200-W supply right up to its capacity and beyond—and that apparently it had failed gracefully, not smoking any boards on the way out. A lot of power supplies do terrible damage as they die, but we never heard of a Turbo-Cool doing that.

I had Alex order me a new 300-W Turbo-Cool. It was too late for them to get it out that day, so it would be at least two days before I could fix my Cheetah 386. Unfortunately, I had a lot of work to do, and there was no way I could afford to take two days off. I had to have a machine. Of course, I have several systems in the other room. I could go use one of them. I could even use Roberta's Gateway, which works just fine. But I didn't like either idea much: my desk and chair are set up pretty well to take care of my back, and I really hate to work away from my desk.

Configuring a new machine is always a learning experience



Cheetah Gold 486/33

The obvious thing to do was to use this as an opportunity to upgrade to the Cheetah Gold 486/33. I'd have to do that one day anyway. There are getting to be just too many nifty programs that require Windows, and while my old Cheetah 386/25 with 4 MB of RAM was plenty adequate for DOS and Desqview, it would be only marginally so for Windows. With Windows, you want about 8 MB of memory, and a 486/25 is none too fast; a 486/33 is much better.

I know there are people who despise Windows because it won't run on their older hardware, and I sympathize. I have stayed with Desqview this past year because I didn't like the Windows performance on my 386/25. That's ironic because Desqview is itself hardware-sensitive. It will work with a 286, but it's sure better with a 386. I was also wrong: a 386/25 is plenty fast enough for Windows, especially if it is run with an intelligent controller, like one from Distributed Processing

ILLUSTRATION: STEVE TURK © 1992

Technology or Perceptive Solutions, *provided you have the right video card.* On that, more later.

In any event, the Gold 486/33 has a fast Perceptive Solutions controller with 4 MB of on-board cache memory and a big 800-MB Siemens hard drive. Cheetah systems run clean without glitches and are among the best development systems available; this one is easily the best machine in the house. Moreover, it was already set up with Artisoft's LANtastic and had the Palindrome digital audiotape backup and Network Archivist software installed. I figured that changing over would never be easier.

I was almost right.

First things first. As it happened, I had used the network to copy everything from the Cheetah 386 to the 486 just the night before in a routine backup. I had done almost no work in the morning before my hike, so the only thing that could be lost was whatever the 386 had picked up from MCI Mail; and since MCI Mail keeps all your messages for a couple of days, I could even check that out. All I'd have to do, then, would be to move the 486 in under my desk and connect it to my Zenith Flat Technology Monitor and my Northgate OmniKey keyboard. Then I'd have to mess about installing QEMM 6.0 and Desqview and getting them right, but everything else should have been fine. Once that was done, I could install Windows.

There was one little problem. When I'd start up the Gold 486/33, it would try to load the mouse driver, but the mouse software wouldn't load. Instead, I'd get a message that the interrupt jumper was missing. That hadn't been a problem for a network server that doesn't need a mouse, but it sure was for a machine that I was setting up to run Windows. Still, how long could it take to run down that problem?

It turned out to eat nearly a day.

The Gold 486/33 originally had a video card that was fast enough, but it wouldn't work with the network. The video card grabbed all the high memory it could find and wouldn't let go, so the network had no place to operate. I replaced it with a Sota Technology video card—a fairly *old* Sota card.

Like the ATI Technologies video cards, the Sota cards have the capability of letting you connect a bus mouse to the card, thus saving either a serial port or a slot for a bus mouse card. Unlike the ATI card, you can buy the Sota card without the mouse port and mouse. On the other hand, ATI has aggressive pricing policies, so you're not paying much for the mouse you get with their board.

On the gripping hand, the mouse drivers that come with the ATI video card aren't much good. But you can use Logitech or Microsoft mouse drivers, which are.

In any event, I had a serial mouse connected to COM2. I removed that, found a bus mouse, and tried to enable it with the Sota card. No joy. As I said, this was an older card. And I figured that while it worked just fine with a 486/25, its bus mouse port just couldn't keep up with the 486/33. OK, use the DIP switch to disable the bus mouse entirely and go back to COM2.

That didn't work, either. In desperation, I got out an older video card, one with no mouse port, and tried that: the mouse still wouldn't work. This time, though, I got an error message regarding interrupt request processing. That led me to look at the *other* cards in the system—and, lo, I found that the LANtastic network card was set by default to use IRQ 3, which is in fact COM2. All I had to do, then, was tell LANtastic to use one of the higher-order

STANDARD IRQS FOR PC COMPATIBLES

Installing a new bus mouse often requires stealing an IRQ from some other device.

IRQ	Function	Remarks
0	System timer	Set by BIOS
1	Keyboard	Set by BIOS
2	Duplexed with IRQ 9	Hard drive on XT
3	COM2 or COM4	Serial port
4	COM1 or COM3	Serial port
5	LPT2	Second parallel port
6	Floppy drive	
7	LPT1	Usual printer port
8	Real-time clock	
9	VGA; duplexed with IRQ 2	
10	Not assigned	
11	Not assigned	
12	Usually not assigned	
13	Coprocessor	
14	Hard drive	
15	Usually not assigned	Sometimes second hard drive

interrupts—LANtastic sets that in software, and I chose IRQ 15—and the Great Mouse Puzzle was solved.

The IRQ Lesson

At that point, I could use either the serial mouse on COM2 or the bus mouse connected through the Sota video card. Sota uses the Logitech Mouse Chip, which runs Logitech or Microsoft mice with the Microsoft Windows mouse drivers or whatever other drivers you like. The Sota card has jumpers that will let you set the mouse interrupt to IRQ 2, 3, 4, or 5, and I suspect that some of you would like that explained.

There has to be a way to tell the computer system that the mouse has done something. This is done with an IRQ. In an AT or PS/2, there are 16 of these, numbered 0 through 15. When the computer sees an interrupt flag, it stops what it's doing to process the interrupt by executing the instructions that its software tells it are associated with that IRQ. Some of these are built into the computer's BIOS. Others are loaded on boot-up. In particular, the mouse software driver will have instructions on what to do if a mouse event—a click or a mouse movement—interrupts the computer.

Now, which interrupt that will be depends on a number of factors. The information in the table comes from Touch-Stone Software's CheckIt, a very useful troubleshooting tool.

Of those, only IRQ 0 through 7 are available on 8-bit peripheral systems (i.e., the original PC and XT, or an 8-bit slot on an AT or a PS/2). That has had the unfortunate effect that many companies design cards that let you use only IRQ 2 through 5. This can cause real problems when you're trying to set up a high-end system.

If you assign IRQ 3 to the bus mouse, it will still disable the COM2 port, and if you try to use COM2, either the port or the mouse won't work. Indeed, if you assign IRQ 3 to the bus mouse and plug a serial mouse into COM2, that mouse can't work. What I tend to do is assign the bus mouse to IRQ 5, since I'm not likely to have two active parallel ports and I may need two serial ports.

Fortunately, Artisoft, Novell, and other companies are now designing their cards so you can use any IRQ from 2 through 15. I wish everyone else would.

Anyway, once I had the IRQ conflict resolved, it was a breeze. I just installed QEMM 6.0 and Desqview and let QEMM's Optimize program do its thing, and in no time, I had Desqview windows of 576 KB. I sure do like QEMM 6.0.

Parallel Blues

Next thing then was to transfer software from other systems. I've found that for temporary hookups the fastest and most convenient way to move lots of files around is to connect parallel port to parallel port with a yellow LapLink "designer" cable and use the new LapLink Pro. I've also found that I can use an Inmac blue cable with gender changer to extend the parallel-to-parallel distance up to about 20 feet without any problem.

This time, though, it didn't work. I had the Gold 486/33 connected to the Cheetah 486/25 Larry Niven uses, and LapLink Pro going on both, but the machines simply refused to acknowledge each other's existence. Very strange. Since I knew that Niven's 25-MHz machine could be connected parallel-port-to-parallel-port with other systems, logic dictated that I check out the 486/33's parallel port. The easiest way to do that was to connect it to the printer.

It wouldn't print. That told me what the problem was, but now what? I could hardly have a primary system that wouldn't print! I called Ron Sartore, the Cheetah's designer. He had no idea why it wouldn't print, but he suspected the little 3Com card. Cheetah computers don't have ports on the motherboard. Instead, they rely on a 3Com card, which has two serial ports and one parallel port. I checked the DIP switches on the 3Com card. They seemed all right, but it didn't work.

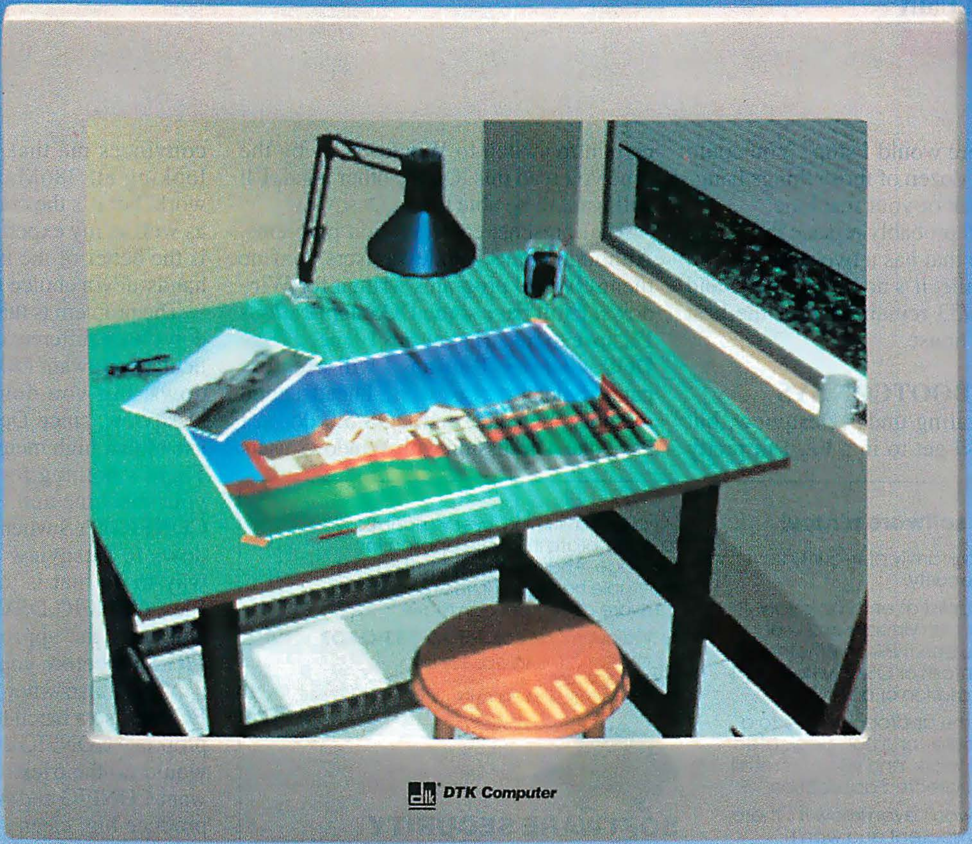
Fortunately, Alex had a spare parallel port card. I plugged it in and the printer worked, so I knew there was nothing wrong with the machine. I looked again at the 3Com card, and I made a discovery: the cable connector from the card to the DB-25 connector was in backward. It probably always had been. It hadn't hurt anything, but it sure wasn't going to work that way. Once that was turned around, the printer worked fine.

Once again, I connected the 486/33's parallel port to LapLink Pro—and it still didn't work. By now I was getting frustrated. I tried Alex's parallel card, and LapLink Pro worked fine. I again called Ron Sartore, from whom I learned something: the 3Com card has only an output parallel port. It's one-way. That was the original IBM PC specification!

I could have fixed that with a different I/O card, but I decided it didn't really matter. My setup has a cable from COM1 to the desktop, where I plug in the USRobotics Courier HST Dual modem, which, incidentally, I've used for more than a year without any glitches, hitches, or problems whatever. When I want to connect to LapLink Pro for file transfer from another machine, such as a laptop, it's easy to unplug the modem and plug in the LapLink Pro cable in its place.

On the other hand, I suspect that the lack of an input capability on my parallel port might cause problems if I were to use any of the software protected by a "dongle"—one of those gizmos that plug into your parallel port. It might not. Some of those dongles use the "out of paper" signal as input and don't need a full parallel input capability.

On the gripping hand, I generally don't use software protected that way, because if



DTK 486 drives high-performance software in PC Week Labs test.

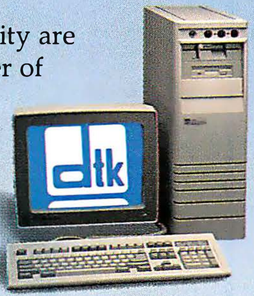
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Circle 53 on Inquiry Card.

I started, where would I stop? You could end up with a dozen of those things hanging off the back of your machine.

One day I'll probably replace the 3Com card with one that has a two-way parallel port. Meanwhile, it's no big problem, and the Gold 486/33 remains by far the best system in the house.

Setting Up: BOOTCON.SYS

I'm still operating under Desqview, but for reasons I'll get to in a bit, I'm pretty certain to switch to Windows 3.1 by the time you read this. On the other hand, I'll still want to be able to use Desqview.

That presents configuration problems. Although some Windows users confine themselves to programs written for Windows, I still have some DOS applications I'll have to run. That means I'll need large DOS windows. It means I will need expanded memory. In a word, I need a good memory manager, and DOS 5.0 doesn't have one. Discussion with Windows users convinces me that there are two worth looking at: 386Max and QEMM. Both work, but it's the consensus of colleagues as well as my experience that QEMM 6.0 is the better of the two. Certainly it's the hands-down choice for Desqview users.

The problem is that Desqview and Windows want different configurations. In particular, you want DOS=HIGH to run Windows, but you don't want it there for Desqview, since Desqview makes better use of that high memory space than DOS. There's nothing for it; you must reboot your machine and change to a different CONFIG.SYS when changing from Windows to Desqview and vice versa. One way to do that is to have two CONFIG files, CONFIG.DSV and CONFIG.WIN, and copy the appropriate one as CONFIG.SYS before you reboot.

You'll also want different AUTOEXEC files, so a batch file that copies the appropriate CONFIG and AUTOEXEC files would do the trick. Then, too, you might want CONFIG and AUTOEXEC files that produce big, clean systems with no TSR programs, and perhaps another pair that set up your system as a network server. Pretty soon, you'll have a dozen files and a complicated batch file just to handle configurations.

Fortunately, there's a better way to handle this. BOOTCON.SYS lets you set up as many as 26 CONFIG/AUTOEXEC files and choose the appropriate one on boot-up. It then gets out of the way. If you spend any time at all fooling with your system, you need a way to recover from disasters. Obviously, you keep a "panic" boot-up floppy disk, but you can save a lot of time if you also use BOOTCON. The new version works with DOS 5.0. Recommended.

Sota Lightning VGA

Making Windows work is a matter not as much of native machine speed as of the speed of the video card and drivers. A 386/33 will perform better than a 386SX/20, and a 486/33 is better than either. However, what really makes Windows seem agonizingly slow is the time it takes to repaint the screen, and that's a function of the speed of the video card. If you're trying to run Windows with an old, slow video card, forget it.

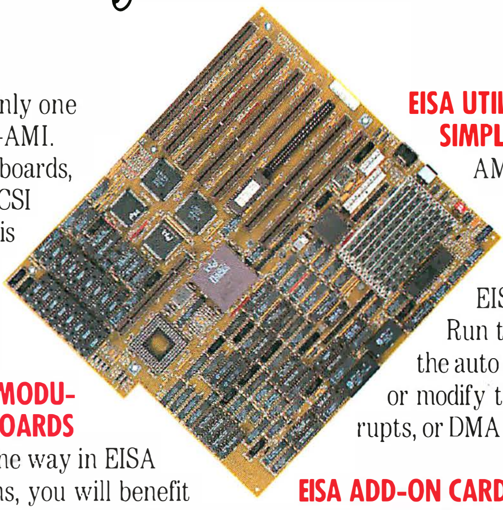
That all changes when you get a video card designed for Windows. Operations that used to take forever suddenly "just happen." If you're contemplating Windows, be very sure you have the right video card, or you'll find yourself disgusted.

Many good video cards are available. Of the ones I've tried, two are definitely good enough: the ATI Graphics Ultra and

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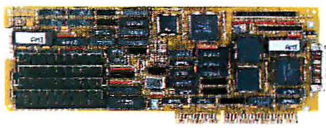
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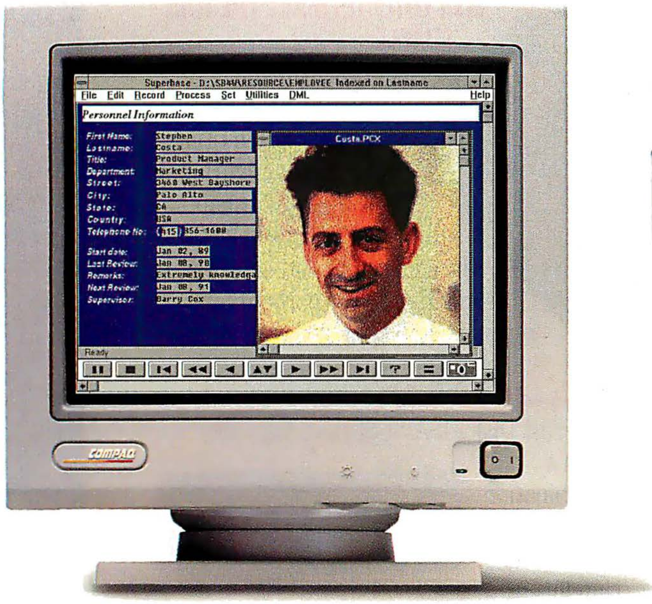
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the Sota Lightning VGA. Both are easy to install, work with most monitors, and come with good software for enhancing Windows. Both have mouse ports; the Graphics Ultra cannot be bought without the mouse port and mouse. I can recommend both cards. So far, I don't have any strong reason for choosing one over the other. More as I learn more, but if you want a good-enough VGA card for Windows, these two won't leave you disappointed.

Installation of the Lightning VGA card is simple enough. In my case, I left the hardware switches at their default settings and put in the card. I installed Windows 3.1 and watched it come up at its usual slow pace. Then I exited Windows, put the Sota installation disk in drive A, and typed INSTALL. The program prompts for the rest. When that was done, I typed WIN /D:X (the switch is so Windows 3.1 will work with QEMM). Windows came up *dramatically* faster, and everything works very well.

I've been impressed with Sota since I first saw the company off in a dark corner at Comdex some years ago. The Lightning VGA card works as well as I expected it to. Recommended.

Samurai Avagio!

As they say on the news, this is just in: a copy of the Avagio desktop publishing system, a floppy V.70 still video camera, some cables, and a copy of a newsletter featuring a color picture of me taken with that camera at the Silicon Northwest Press Reception at Comdex. I'm told not all of this is available in the U.S. just yet, but it will be. The results are impressive.

The Yashica Samurai is a still digital video camera that takes monochrome or color images that can then be transferred to your VCR and saved on tape or input into your computer through a video-capture card. The video pictures can be digitally manipulated and inserted into desktop publishing documents. The notion is that everyone knows how to use a camera, while everyone does not know how to use a scanner.

Dycam

The Dycam Model 1 digital still camera is monochrome only, but it requires no special equipment to get the images it takes from the camera into your PC or Mac. It comes with all the cable adapters and software that you'll need. There's also software you can port across to the camera to convert it from a flash system to "tripod"—meaning longer exposure for poor light conditions when you don't want flash.

For PCs, the images come out as TIFF files. You can transform them from that in the usual way, and they'll feed nicely into newsletters or other desktop publications. They can also be incorporated into PowerPoint displays and output onto View Graphs.

You can operate the Dycam on its own, in which case it's about like any small camera with a 32-picture roll. After you take 32 pictures, you have to download them to clear the Dycam's memory. You can also operate the Dycam when it's attached to your computer—any PC or Mac with a serial port—in which case you can control it from the keyboard.

Now there is no question that the Yashica Samurai is more sophisticated, what with changeable recording disks (they're tiny floppy disks a bit like the rather unlamented Zenith microfloppy disks), zoom lenses, and suchlike. But the Dycam is less expensive and a great deal more portable.

The important thing to note here is that the images are digitized in the camera. This means you can take this camera, with

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or without your laptop computer, to a library and use it instead of a scanner. Scanners don't connect to serial ports. The Dycam does, at up to 115,200 bps. Logitech has licensed the Dycam technology and is now shipping its own line of camera scanners and Logitech-developed software.

Look for further developments in this field, in both digital recording cameras like the Dycam and imaginative ways to integrate video camera images into your personal computer system.

Sound Boards and Multimedia

In the past year, the Brown-Wagh Sound Blaster Pro has become the de facto standard for multimedia systems. It's supported by nearly all the major software designers, including the game companies, which are currently the most important sources of sound for PC systems.

This made for a real problem for Media Vision's Pro Audio Spectrum. This card has nearly everything you'd want for multimedia: a joystick port; sound, including a MIDI port for two-way connection to a MIDI connector box and thence to keyboards, synthesizers, and so forth; onboard FM synthesizers to generate 22 different voices; excellent software; stereo digital recording; and a SCSI port that should be able to control a CD-ROM or other SCSI device, saving you a slot.

All in all, it's a very good system. If you're going to use it to generate music, to work with Lotus Freelance to build presentations with sound effects and speech, or anything like that, I wouldn't hesitate to recommend it. The problem, though, is that Media Vision used a nonstandard digital-to-audio conversion. That nonstandard conversion means that many major games, and a lot of other multimedia software, simply don't work with it.

Fortunately, they're fixing that. I am assured that the new version (which should be out now) will be Sound Blaster-compatible and will feature the new OPL-3 sound chip. That's important because, I am told, the OPL-3 is good enough to blow everything else away. Stay tuned. We'll see. Mind you, I don't have the new version of the Pro Audio Spectrum, but assuming that it performs as promised, it's much needed: a board of near-Roland quality without Roland's price. Try it on digitized speech before you buy it, but with that stricture, recommended.

One final bit of news: Disney and Phoenix have signed a deal whereby the Disney sound system will be integrated into new versions of the Phoenix BIOS. After that, your PC will be able to talk to you about as well as the Mac does (i.e., digitized speech, which takes up lots of disk space but has good quality). Before long, your PC will be able to have Spock's voice say "That should prove interesting" when you reboot....

System 7.0 and Quadra 900

We've temporarily dismantled the Mac IIfx to give its place to a new Quadra 900 running System 7.0. The result has brought about some minor problems. Apple has for years been warning software designers not to write self-modifying code, because the 68040 chip wouldn't allow that. Alas, a number of older programs do that or violate some other published system restriction, and thus won't work on the Quadra. In addition, many of the software-conversion filters for desktop publishing programs just didn't work properly with the Quadra and System 7.0.

This is all changing. New filters are available on BIX and other BBSes. Many companies are revising their software, and every month we get an upgrade of yet one more major program. As an example, the

newest version of Strategic Conquest, long our classic Mac war-game favorite, runs just fine. So does Microsoft Word and, now that we have the proper filters, Aldus PageMaker.

We also have a public domain program, available on BIX, that will automatically detect programs that won't work with the Quadra in 68040 mode and switch it to some mode that will work. Fair warning: after you have experienced the blazing speed of the Quadra in 68040 mode, you will really *hate* it when it slows down.

You'll hear more about the Quadra in times to come. All told, the transition has been relatively painless. The Quadra is a worthy successor to the IIfx. You'll love it.

The Quadra runs System 7.0, and it won't run any flavor of System 6.0. I don't regard that as a defect. We also have a Mac Classic II, which has replaced Richard's ancient Mac Plus. Richard is our number four son, who is at present an undergraduate at UCLA and the perfect user for testing computer systems. He grew up in Chaos Manor expecting to be able to use computers while refusing to learn anything at all about them. Given his choice of nearly any kind of computer, he chose a Mac. He loves System 7.0. Of my four sons, one uses a PC, two use a Mac, and Alex understands and uses both. Meanwhile, my wife publishes the L.A. Opera League newsletter on the Mac.

Later this spring—I think the June issue—I will devote a major part of the column to outfitting the Classic II: recommended hardware and software, including shareware and public domain utilities, all tested by Richard and his debate team. I'll also look into System 7.0 versus Windows.

Knowledge Adventure

The short description of this program would be "a hypertext-linked general database." Knowledge Adventure is several megabytes of images and text arranged for browsing. Although this is a DOS product that runs just fine under Desqview, it has a Windows feel to it and requires a mouse. Ideally, you'd want VGA and a Sound Blaster, although it will work with EGA and no sound board.

The interface is fully GUI, and navigation is with mouse-clicks to self-explanatory icons. There are icons for music, architecture, science, and so forth. There is a time-scale bar ranging from 10 billion B.C. to the year A.D. 2000. There is a distance scale running from 100 miles to intergalactic. You can use the mouse to move around in time and space. Each stop brings up a different picture: Stonehenge, Albert Einstein, Orville Wright, Beethoven, Aristotle, Magellan, chariot races, *Apollo 11*, and so on. Each picture has associated text. In addition, there are links, some obvious, some not: Einstein links to *The Atom at War*, which describes the destruction of Hiroshima and Nagasaki; that is linked with the zeppelin *Hindenburg*, which is linked to Orville Wright.

Many pictures have multiple links: click on the spacecraft in the picture of *Apollo 11* on the moon and you get one link, click on the stars behind the astronauts and you get another, and click on the astronauts and there's another yet.

I'd have killed for this when I was a kid. If you know a bright youngster with access to a computer, get this program, set it up, and get out of the way. From the touching story of how Beethoven, deaf, thought his Ninth Symphony a failure until his assistant turned him around to see the wildly cheering crowd, to the architectural details of the Hagia Sophia in Constantinople, Knowledge Adventure is full of the kind of trivia that I have always loved. It *is* limited: there are only eight items under the music icon, for example. On the other hand, they are making up new databases that can easily be integrated into the Knowledge Access engine.

I liked it a lot.

Portable REXX

I haven't time to do this product from Kilowatt Software justice. The language is fully described in *The REXX Language: A Practical Approach to Programming* by Michael Cowlinshaw (Prentice-Hall, 1990, ISBN 0-13-780651-5), which is available from Kilowatt. REXX is an easily learned command language that some have described as a "superbatch language." It does file operations and math (including scientific math). It appends records to files, prints things on command, and generally functions as a software robot on your PC.

Amiga users consider REXX for the Amiga a secret weapon—with reason. If you like mucking about with your computer, you'll almost certainly like this.

Crescent Tools

Crescent Software's QuickPak Professional BASIC tools are quite simply essential if you are going to do much programming in compiled BASIC for the PC. These routines either do things that the standard Microsoft BASIC compiler doesn't do or, because they're written in assembly language, do them much faster and more efficiently.

Now there's a QuickPak Professional for Windows. In my judgment, it has always been easier to write Windows programs in Visual Basic than in C, and the resulting code will be very nearly as efficient and working long before the equivalent C program will be. Now Crescent makes that even easier. Highly recommended.

Winding Down

As usual, I'm out of space long before I'm out of things to write about. There are a zillion new CD-ROMs. Get the catalogs from Quanta Press and the Bureau of Electronic Publishing for details. My favorites for the month are the Monarch Notes—*all* of them—from the Bureau and Apollo—everything about the U.S. moon missions—from Quanta.

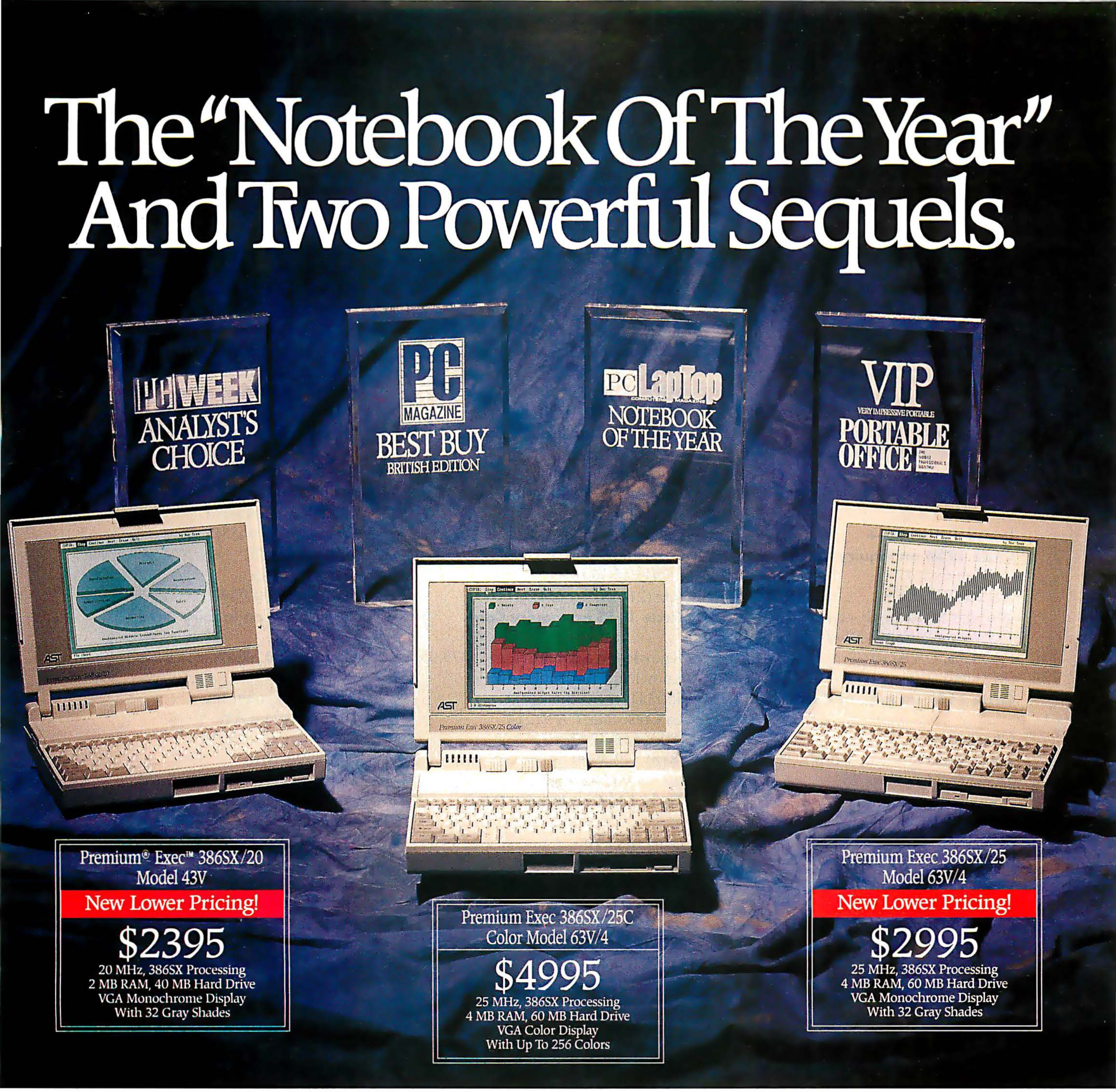
I'm currently carrying the AT&T Safari laptop. More next month, but there's really a *lot* to like about the Safari. Moreover, it comes with the new Logitech TrackMan Portable trackball. Logitech's trackball for laptops beats the previous winner, the Microsoft Ball Pointer, and by quite a lot.

The shareware of the month, available from BIX (see the ibm.utils listings conference), is DISKMON. This is a small TSR that tells you all the error messages DOS sees but doesn't report to you. You'll be astonished the first time you run it. Developers need this.

The books of the month are Peggy Noonan's *What I Saw at the Revolution: A Political Life in the Reagan Era* (Ivy Books, 1991, ISBN 0-8041-0760-2), an interesting account of a remarkable young woman's years in the Reagan White House and one of the few such books that stays near the truth rather than trying to exaggerate the importance of the author; and Paul M. Kennedy's *Grand Strategies in War and Peace* (Yale University Press, 1991, ISBN 0-300-04944-7), a historical analysis of the present by the author of *The Rise and Fall of the Great Powers.* I don't always agree with either Kennedy or Noonan, but reading the two together is an insightful experience.

Next month, the annual Chaos Manor User's Awards, including the year's best in a number of hardware and software categories, and my annual orchid and onion parade. ■

Jerry Pournelle holds a doctorate in psychology and is a science fiction writer who also earns a comfortable living writing about computers present and future. Jerry welcomes readers' comments and opinions. Send a self-addressed, stamped envelope to Jerry Pournelle, c/o BYTE, One Phoenix Mill Lane, Peterborough, NH 03458. Please put your address on the letter as well as on the envelope. Due to the high volume of letters, Jerry cannot guarantee a personal reply. You can also contact him on BIX as "jerryp."



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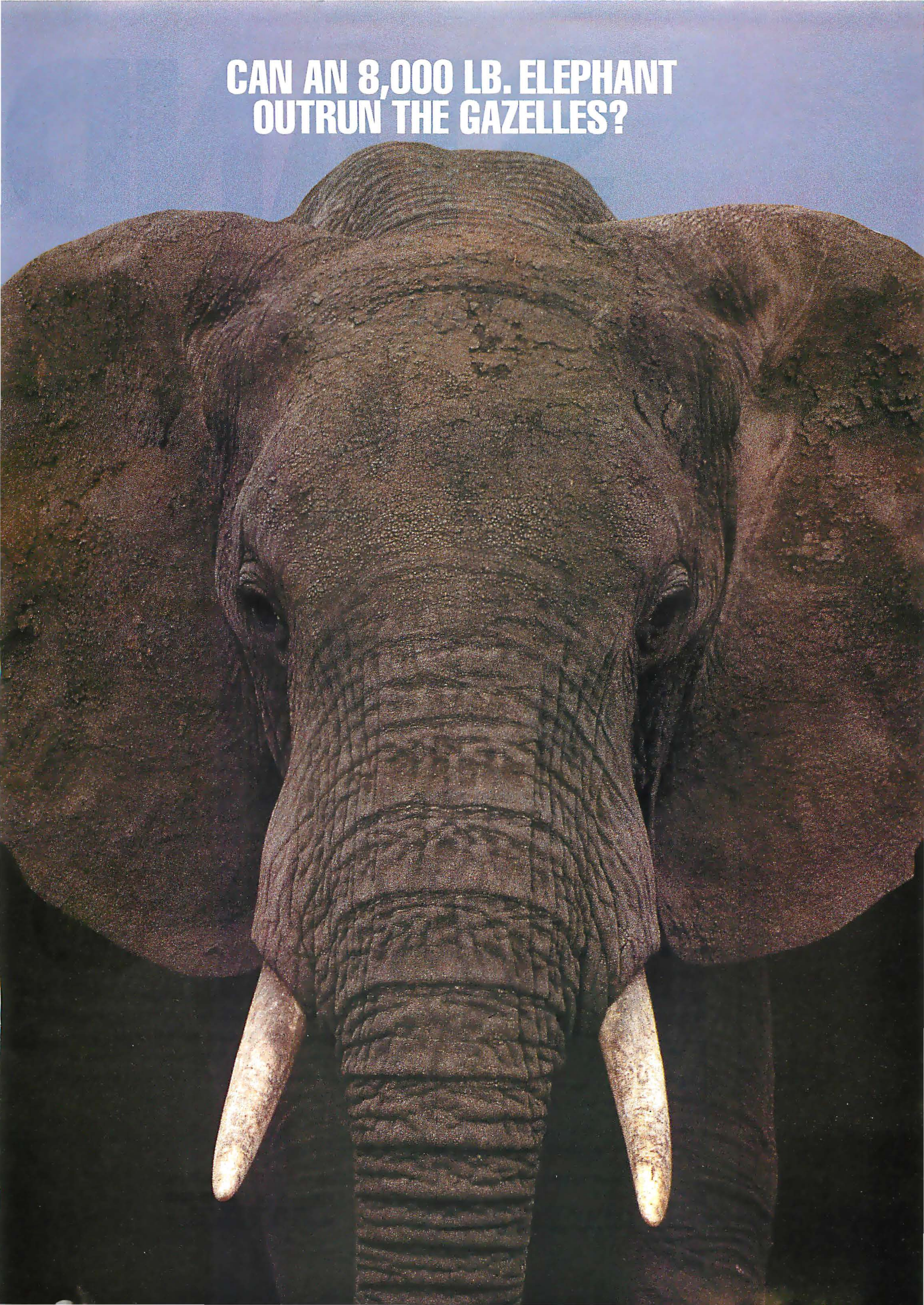
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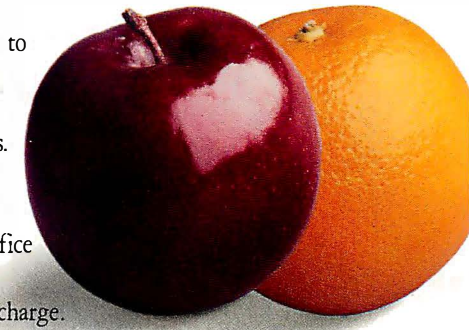
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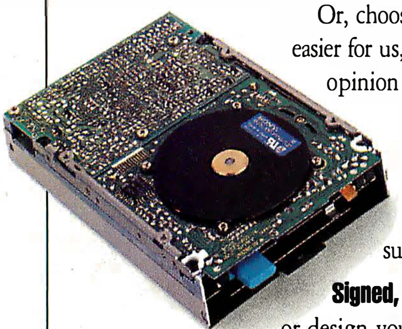
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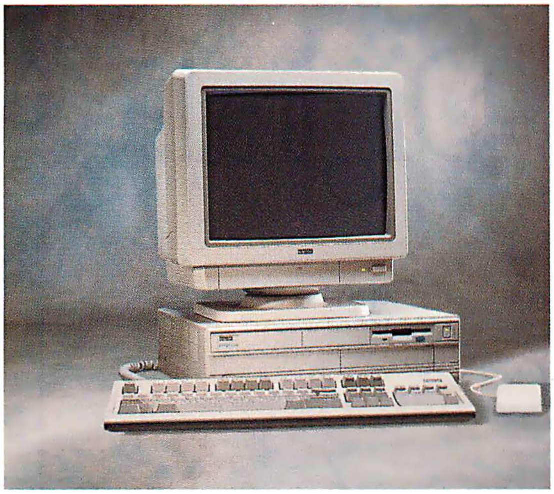
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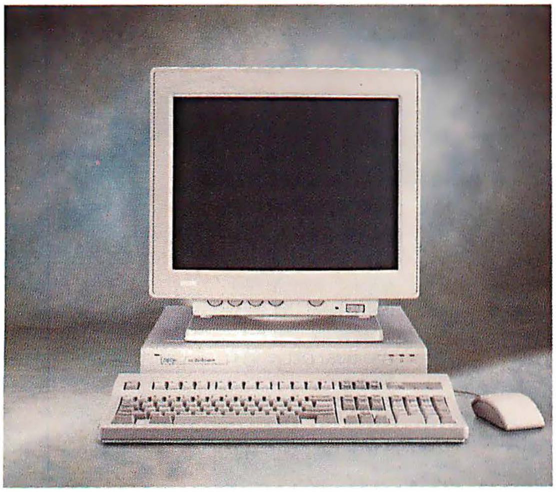


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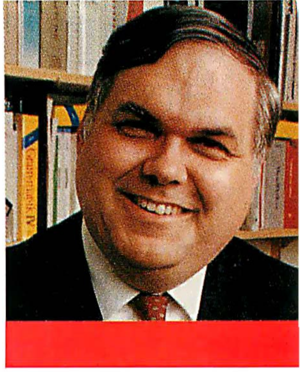
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WAYNE RASH JR.

WINDOWS MOVES OUT

Computing on the road has always been a pain. The problem is that the things you do at the office are usually comfortably within the state of the art, but the same work stretches the state of the art considerably when you're away from your home base. The fact remains, though, that many business users require exactly the same capabilities when they travel as they do when they are back at their offices. If this means that they must use Microsoft Windows when they travel, then they must be prepared to stretch the state of the art. Sometimes, unfortunately, the industry isn't quite ready for all the stretching that may be required.

On the Road Again

I had the opportunity to test the amount of stretching that both the technology and the industry will support during a series of trips last fall. These trips took me from the beaches of Waikiki to the cobbled streets of Prague, and in the process I learned a lot about what it's like to use sophisticated hardware and software while traveling.

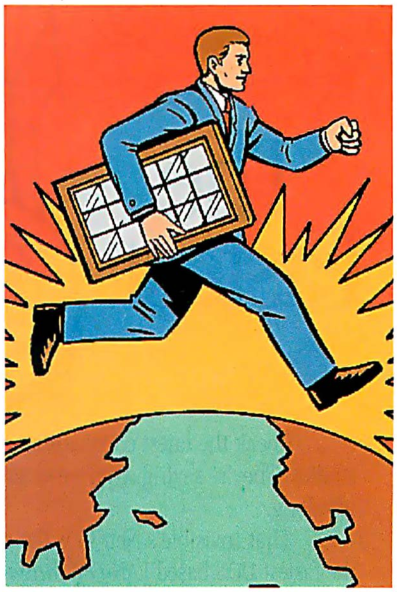
Over the past year, I've begun using Windows-based software for a growing portion of my work. I started with Excel for Windows because of its clear superiority over Lotus 1-2-3. That led me to start using Word for Windows for some tasks and Microsoft Project for project management. Still, I did most of my writing with WordStar and WordPerfect, and that meant that much of my work didn't require Windows and therefore didn't require terrific power. Most notebook computers would work fine if all I had to do was write.

Two things changed this past fall. The first was that I found myself having to create or modify presentations while traveling. The other was that Windows-based word processing finally reached the point where I didn't mind using Windows-compatible products for serious writing. With these changes in requirements and capabilities, I found that the benefits of having a consistent graphical interface exceeded the drawbacks, even while traveling.

In Honolulu, for example, I needed access to Microsoft Project during discussions with both my client and with subcontractors during the start-up phase of a network installation. While I could have carried a floppy disk and used a computer at the client's site, this presumed that the client had Microsoft Project installed on a computer that would be available for my use. Since I couldn't make that assumption, I needed to take along the software and a computer that would support it.

Likewise, while I was in Prague, I needed to write and send my column for BYTEWEEK, and I needed the capability to create documents and presentations for the Czechoslovakian client. I can write my column using nearly anything, but producing clear, attractive, and professional-looking documents and presentations requires sophisticated tools. This was one area where having a Windows-based presentation package, such as PowerPoint, was a plus. Even better was the new WordPerfect for Windows, which allowed me to use a GUI-based word processor that would support the diacritical marks that are used in the Czech and Slovak alphabet.

Better notebook computers make traveling with Windows a workable proposition



While I could have done without Windows on these trips, it would have been a lot harder, and it would have meant using tools different from those I use at the office.

During my visit to Czechoslovakia, I enjoyed the unique sensation of starting this column in a thirteenth-century palace using WordPerfect for Windows running on a Zenith Mastersport 386SLe notebook computer—a memorable contrast between old technology and new.

The State of the Art

It takes a very capable machine to support the requirements I had on last fall's series of trips. On one hand, I needed a computer with enough memory and disk space to support Windows and several applications. On the other hand, I needed a computer that would be small and light enough that I could carry it through airports around the world, that would have enough battery life that I could power it up for security personnel, and that would be functional on an airliner if I needed to use it there.

I used two computers that met all these requirements: the Librex 386SX/20 and the Zenith Mastersport 386SLe. The Librex is typical of moderately priced 386SX notebook computers, while the Mastersport's 25-MHz 386SL CPU, practical design, and exceptional screen make it clearly the best Windows-capable notebook computer

ILLUSTRATION: BRAD HAMANN © 1992

available today. The Mastersport is also unperturbed by the rigors of international travel. The standard power supply works equally well on 220-volt, 50-cycle power in Europe, 115-V power in the U.S., and 100-V power in Japan. Battery life on the computer is enhanced by the standard power management features in its Intel 386SL processor chip. And the Mastersport is small and light enough to be useful even in the depths of the coach section on a Lufthansa 747.

What's also important is that both the Mastersport and the Librex have backlit triple-supertwist screens with sufficient clarity and contrast to make Windows use reasonably pleasant. While neither machine has a color screen, I didn't find that to be much of a problem. In fact, the Mastersport's 9-inch screen is good enough that clients tended to gather around to admire it, and it's large enough that I could use PowerPoint's slide-show capability to produce presentations.

Entanglements

Of course, capability is one thing and actual use is another. While there's a lot of excellent Windows software available, and while there's finally some decent hardware available for use when you travel, trying to actually use your handy Windows software when you're away from the office could get you into serious trouble. The reason is that the licensing practices of some software companies simply haven't kept up with the technology— or with reality, for that matter.

Windows itself is usually not the problem, since it seems to be bundled with just about every computer sold these days, but the applications are a different story. In the course of preparing this column, I used several packages on the road that I also use at the office. There are also packages that I couldn't legally use, so I didn't.

WordPerfect for Windows was the easiest solution. WordPerfect Corp. (Orem, UT) has modified its licensing agreements so that you can install WordPerfect on any computer you want as long as you use only one copy at a time. This is perfect for the traveling business user, who will use the copy on the desktop machine at the office and the copy on the laptop machine when traveling.

With Microsoft, the licensing situation can best be described as somewhat weird. It lets you install applications on a laptop or home computer, provided you use the copy on a dedicated computer 80 percent of the time. You can get around this requirement if you actually carry the physical copy of the software license with you when you use the software. But how do you measure 80 percent? Over what period of time? Does this mean that users who travel a lot must have two copies of Microsoft applications while those who don't need only one? Let me know if you figure out the answer to this one.

DCA, meanwhile, has one of the better Windows communications packages around, but don't try to use the same copy on the road that you have back in the office. The license for DCA's Crosstalk for Windows follows DCA's outmoded, mainframe-based concept of allowing only a single copy of the software, plus an archival copy. You can have a copy of Crosstalk for Windows on the office machine, or a copy on the laptop, but to have both, you need to buy two copies. This concept is ludicrous and only succeeds in making software pirates of otherwise honest business users.

Sadly, far too many software vendors insist on silly license requirements such as those used by DCA. Limitations such as those and, to a lesser extent, bizarre

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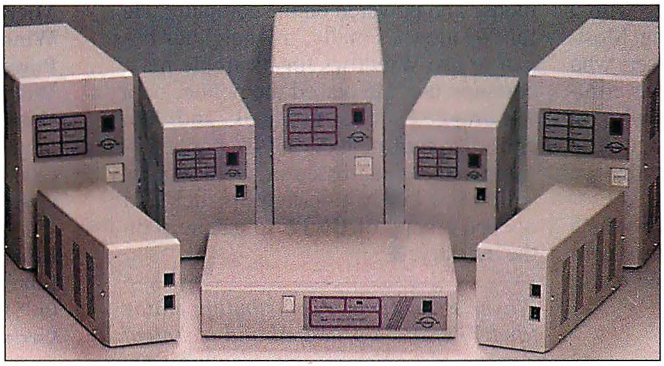
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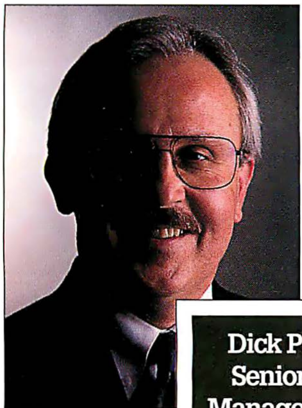
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Dick Patefield, Senior Project Manager for Store Systems Support, JCPenney

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limitations such as Microsoft's, have no discernible positive effects. They can irritate users, or they can cost users more money than they should, or they can result in a user choosing a package with a sane approach to software licensing. Mostly, though, they irritate business users who don't like thinking of themselves as criminals and who don't like vendors who ignore life in the real world. In my case, I left Crosstalk for Windows installed on one of the office machines and used Procomm Plus on the road. It might not be a Windows package, but Datastorm Technologies understands how people really use computers.

Real-World Use

Now that Windows works on the road, what do people in the real world do with their new Windows-capable computers? My seatmate on one flight was typical. I watched him as I sipped a glass of Dom Pérignon from the comfort of my first-class seat on a United 747. First, he unloaded a pile of spreadsheet pages, a few documents, and a presentation. Next came a Compaq notebook computer and a Ballpoint mouse.

After the airplane took off and our glasses of champagne were refilled, my neighbor opened his tray table and placed the Compaq in front of him. He attached the mouse and powered on the computer. He ran Windows. Finally, my neighbor began to use Windows for its single most common use. He placed the pointer on a 10, dragged it over to a jack, and then clicked to turn another card over as he became happily engrossed in another try at solitaire. I silently toasted his luck and opened a copy of BYTE to catch up on the industry. ■

Wayne Rash Jr. is a contributing editor for BYTE and a principal and technical director of the Network Integration Group of American Management Systems, Inc. (Arlington, VA). He is coauthor of two books for business network users: The Executive Guide to Local Area Networks *and* The Novell Connection. *You can contact him on BIX as "waynerash" or in the to.wayne conference.*

Your questions and comments are welcome. Write to: Editor, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458.

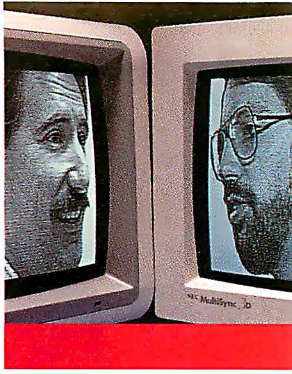
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Mastersport 386SLe $4995
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WordPerfect for Windows $495
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BYTE editors debate the issues with contributors, readers, and industry experts

THE FUTURE OF PEN COMPUTING

Roundtable is a forum in which BYTE editors, contributors, readers, and industry experts debate key issues that affect how you purchase and use hardware and software. The "conversations" take place on BIX, where you can participate in the round.table conference.

Editor's note: *This month, BYTE invited pen-computer software and hardware developers to discuss pen-computing technology. Senior editor Rob Mitchell moderated the discussion.*

Stylus-based input systems started with niche-market forms-based data-collection applications. New pen-specific operating systems such as Windows for Pens and PenPoint promise to widen the market for these machines. Who will buy these systems, and for what uses?

DAN BRICKLIN: People will buy [pen computers] because they can do what other computers can't—[you can use them] while standing up or in other situations where a keyboard is inappropriate. Another example is when you want handwritten text or illustrations, such as sketches of damage to a motor vehicle.

Laptops and mice don't mix well. In many situations, people use a pencil and paper, not a laptop, because the information to be captured does not lend itself well to a keyboard or a mouse. Unfortunately, much of this information needs to be stored and retrieved, and computers would be very helpful if only they could accept handwriting without translating it. Many people will find pen computers more natural, even with slow handwriting recognition, just as some find dictation natural, and others don't.

NICHOLAS BARAN: Most situations that require standing up and using a pen as an input device are *task-specific* activities. Initially, I see a very specialized market.

Pen-based vendors are missing the mark in selling the machines as general-purpose computers at this stage in the game. Perhaps a few executives with generous expense accounts might buy pen-based machines as a luxury item, but we are still far away from these machines becoming a mass commodity.

STEVE LIFFICK: Mass-market acceptance of the technology will have to wait until prices come down from the current range of $3000 to $5000.

This is why it's important to appeal to today's notebook buyer. [This person] is prepared to buy a machine that runs all of [his or her] current applications. If we can offer a notebook computer with enhanced portability and usability, key pen-specific applications, and a really cool platform to boot—all for incremental cost—we can win the buyer from the generic notebook-computer market.

KEN DULANEY: We see four types of pen computers emerging. These are clipboards, characterized by large screens, long battery life, and low prices; tablets, characterized by large screens and high-speed processors; pentops, pen-enhanced notebooks; and consumer hand-helds, characterized by small size and weight.

Two subclasses are consumer and industrial. Consumer hand-helds are "Pen Wizards." Industrial hand-helds have a high degree of ruggedness.

Clipboards and industrial hand-helds are highly vertical. Pentops and consumer hand-helds are highly horizontal. Tablets could play in either market.

We see three software choices for pen computers: Windows for Pens, which is highly horizontal; PenPoint, which Go wrote to be horizontal but could be adapted to vertical applications; and Grid's PenRight, developed for use in custom applications.

We see the following match-ups. Clipboards: PenRight for now because they usually have less-than-386 performance and cannot run Windows for Pens

NICHOLAS BARAN
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Pen-Based Computing: The Journal of Stylus Systems

DAN BRICKLIN
Vice President,
Boston Development Center
Slate Corp.

JEFF DAO
Director of Applications Engineering
Communication Intelligence Corp.

KEN DULANEY
Director of Marketing for Portables
Grid Systems Corp.

HOWARD EGLOWSTEIN
Testing Editor, BYTE Lab

STEVE LIFFICK
Program Manager,
Windows for Pens
Microsoft Corp.

KEVIN MANKIN
Director of Product Marketing
Momenta Corp.

ANDY REINHARDT
Editor in Chief, BYTEWEEK

or PenPoint. Tablets: All three operating systems. Pentops: Windows for Pens. Consumer hand-helds: PenPoint, which is scalable and horizontal. But since not many people know what operating system is on a Sharp Wizard type of product, other OSes could play. Industrial hand-helds: PenRight for now.

Our studies show that the most successful pen computer will be the replacement for the Sharp Wizard ([which sells for] under $1000). This is a highly horizontal product and generally a companion to a desktop machine.

JEFF DAO: We must shake off our perception that the U.S. is the only market in the world. Many languages make a keyboard look ridiculous (Japanese, Chinese, and Korean are good examples). Pen input allows computers to be localized much better for the world market, and this benefit applies not only to hand-helds, notepads, and pentops, but also to desktops and workstations. A good example is Communication Intelligence's MacHandwriter, which Apple markets in Japan. It offers direct entry of over 3000 kanji characters and uses the wealth of existing Macintosh applications such as PageMaker, Word, and Excel.

ANDY REINHARDT: Pen-based computing doesn't have to be synonymous with mobile computing, although that's the most obvious point of entry. There will be whole classes of applications developed for mobile versus mouse-substitute pen computing. Perhaps Grid and other vertically oriented solutions like hand-held terminals will define mobile pen computing, while pentops and high-end tablets like NCR's 3125 will constitute the executive class that runs 386-based GUIs.

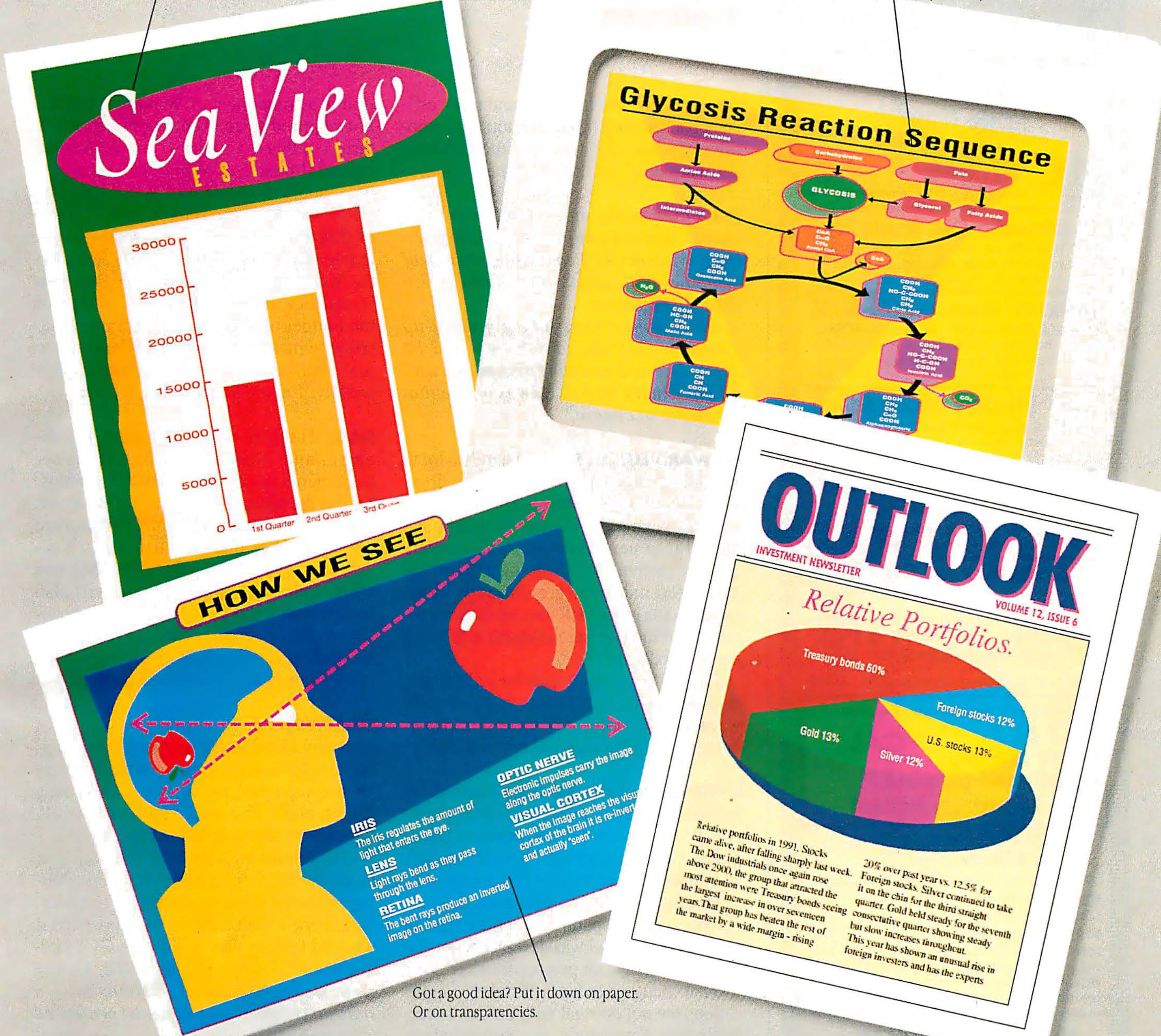
For networking, PenPoint includes the interesting In Box/Out Box feature, which queues up messages and automatically recognizes the presence of a network. This is especially ideal for radio-based communications: As soon as you come within receiver range, your messages flow in and out without your having to do anything.

KEVIN MANKIN: Mobile computing is essential to the advancement of pen-based software. The previous generations of portables all ran software developed for a desktop. Since a pen enables software to be accessible in meetings, software must evolve that is less demanding to a user in a meeting.

Less-demanding, more-intuitive, and more-efficient software will result from software [developed for use] in meetings, and that software also will be less

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demanding, more intuitive, and more efficient back at your office desktop. The "mobile software tail" will wag the "desktop software dog" for the first time.

Pen-based applications developers must choose between competing operating systems. Windows for Pens is an extension of Windows that works with existing Windows applications.

Other competitors take a ground-up approach. Go Corp.'s PenPoint is a 32-bit object-oriented operating system that uses a flat memory model. How is a potential developer to choose?

HOWARD EGLOWSTEIN: There's a lot to be said for writing to a standard environment. Windows for Pens seems like a solid idea: Take a popular environment and extend it to new hardware. The problem is, if the people who are going to use these pen-based machines are primarily interested in data entry, will they really need access to Windows spreadsheets and word processors?

I'm not developing pen-based applications anymore, but if I was, I'd swing toward an environment with less emphasis on compatibility with old applications.

LIFFICK: Much ado has been made about Windows for Pens being inherently "hampered" by, or limited to, desktop transplants because it existed before the pen. This simply is not so. Our application programming interface was designed to leverage the special capabilities of the pen. The pen API is new and was designed to enable the creation of cool pen applications.

That many of today's Windows applications are not optimal with the pen is certainly true. Fortunately, pen-optimized applications like Slate's PenApps are being written for Windows for Pens.

Corporate developers are picking our environment because of the large number of development tools available for Windows for Pens. Visual Basic has been especially good at helping us create mock-ups of applications on the fly. Once we show MIS types that you can do pen applications and do them quickly, they can base their decisions on other factors. The OS is a known quantity, and many folks understand how to write for Windows.

Windows is a sophisticated environment designed for desktop machines. Won't Windows for Pens be more resource intensive than native pen OSes?

LIFFICK: Windows is basically a bunch of .DLL and .EXE files—some required and some not. For example, the Write application is a component of Windows, but it is not required to run other applications. It turns out that if you throw out all the nonessential pieces of Windows—as would be done by the vendor of a vertical solution—Windows for Pens requires 1.6 MB of disk space and can run several average applications in 2 MB of RAM. Actually, the scalability of Windows for Pens is a pretty nice feature, although it can force the builder of a resource-constrained machine to make some tough decisions as to just what files are really required. (Personally, I'd say Solitaire is a must!)

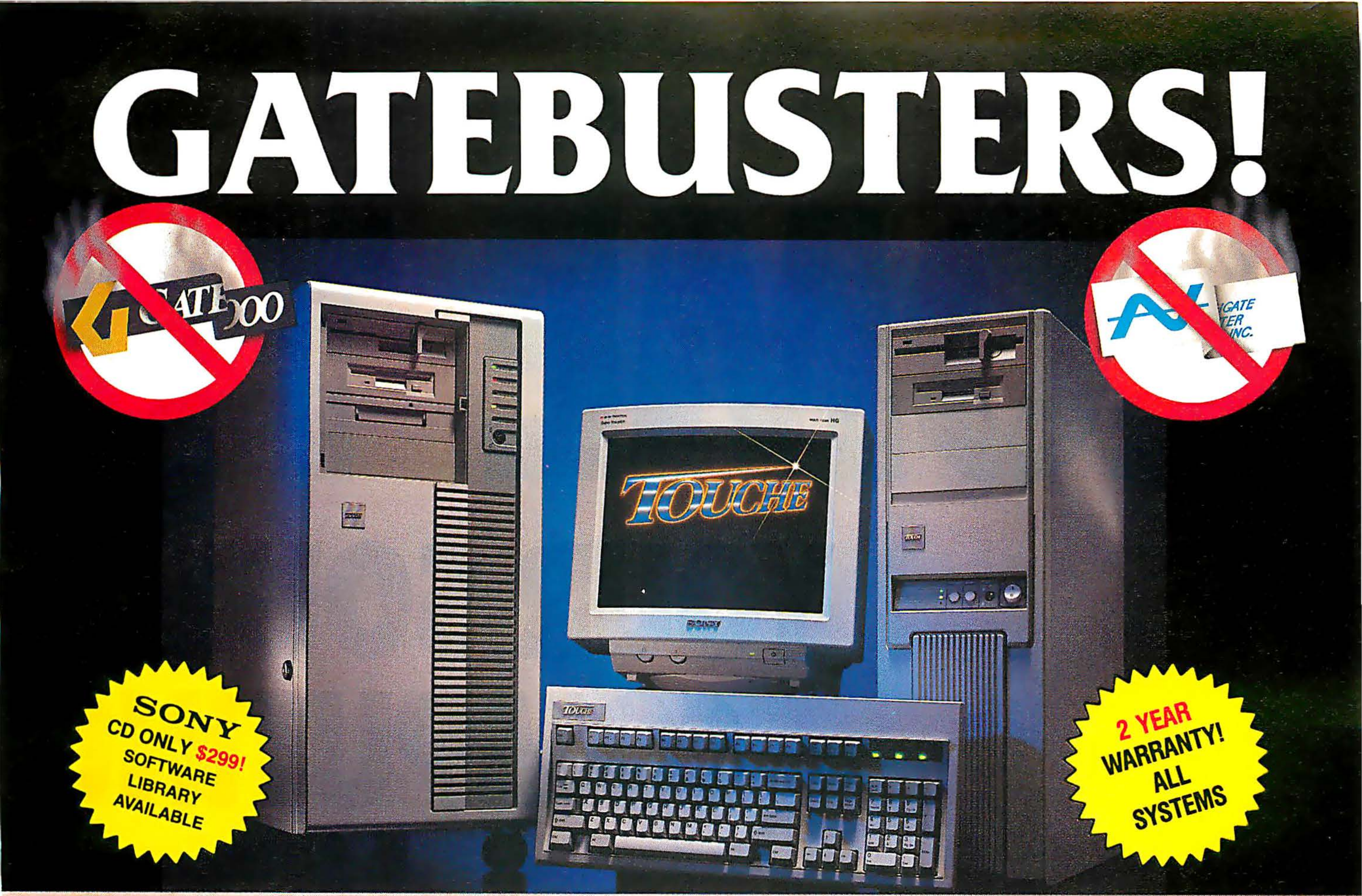
DAO: The pen-computing market is diverse, and [different] applications requirements justify different OS solutions. So far, the press has focused on PenPoint, Windows for Pens, and PenDOS. But there are other OSes out there that many businesses use, such as the Mac OS, OS/2, and Unix. Pen extensions to these will also have a strong market potential. The benefits of pen computing are also relevant to workstations and smaller hand-held computers, not just notepads and pentops.

EGLOWSTEIN: At Hindsight, we didn't have any existing applications to convert, our machine wasn't going to be remotely DOS compatible, and we wrote everything from scratch. That forced us to take a fresh look at the pen as an input device.

Our model was the lined school pad (with the big 1-inch lines). It had no concept of windowing, and making the interface work would have been impossible if we tried to start with an existing GUI. [Editor's note: *Prior to joining BYTE, Eglowstein was a cofounder of Hindsight—a start-up company that designed pen-based workstations for special education classrooms. Hindsight's Letterbug was built to teach handwriting to dyslexic students.*]

DULANEY: Pen-enabling an existing OS is a short-term fix. Ultimately, the OS or environment has to be rewritten to take advantage of the pen. At Grid, we use a GridPad to allow people to sign into our building. Pen-enabling an existing software package would have been a complete failure. We had to use many software interface techniques that were not even considered in keyboard- or keyboard-/mouse-aware applications. The folks at Microsoft, Go, and Grid have started all over again in designing the software. Successful pen computing can require no less.

Next month the roundtable on pen computing continues, as participants discuss the limits of handwriting recognition, display technology, and other issues. ■



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FEATURE

Software Without Walls

Distributed object management systems can integrate diverse operating systems and applications and optimize your current systems

HERBERT M. OSHER

To stay responsive and competitive, your company needs access to the most current and accurate information available. However, most of today's computing environments include a complex patchwork of incompatible mainframes, minicomputers, personal computers, and systems software.

Gaining transparent access to your information means coping with multivendor networks, "legacy" (i.e., entrenched) applications, diverse operating systems, and competing standards. The open systems intended to fill these needs are too often walled in by inflexible applications and complex environments.

Organizations today need to optimize their computing systems. They need an environment that builds and integrates diverse operating systems and applications—essentially, software without walls. One solution is a new class of object-oriented technology called *distributed object management* (DOM) and provided by companies like HyperDesk, DEC, Hewlett-Packard, and Sun Microsystems.

Why Object-Oriented Software?

The basic components in an application change less frequently than do the functions that an application performs. For example, a spreadsheet cell can be an object. The functions this cell supports—Calculate, Move, Format, and so on—may change over the application's lifetime, but the object itself—the cell—remains constant. The objects are extensible, and, therefore, so are the applications.

If you use predefined objects, you don't have to reinvent them each time a new service or application comes along. For example, in developing an application that uses word processing functionality, you can reuse the word processing objects.

Reusability saves both design and development time and reduces the time to market for new products. In an object-oriented system, the software is modular in design, so the pieces are reusable.

What Is an Object?

Every component in an object-oriented system has data and operations that define it as a particular kind of object. For example, a workstation window, a spreadsheet cell, and a wolf can all be modeled as objects. Each object comprises certain information (i.e., the data) and can be used in certain ways (i.e., its operations).

Objects with the same data and operations are categorized into types. For example, the workstation window belongs to the Window object type, the spreadsheet cell

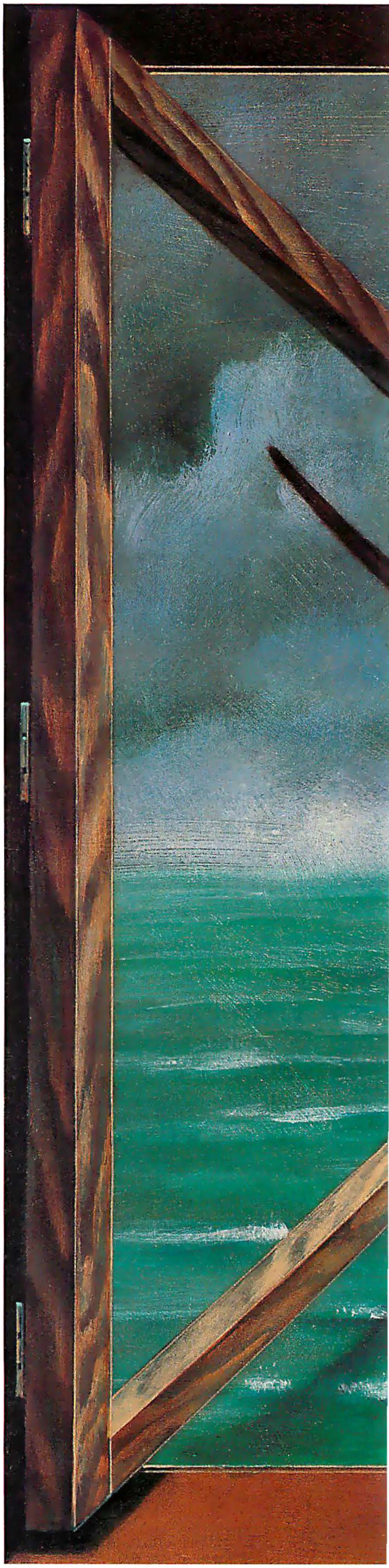
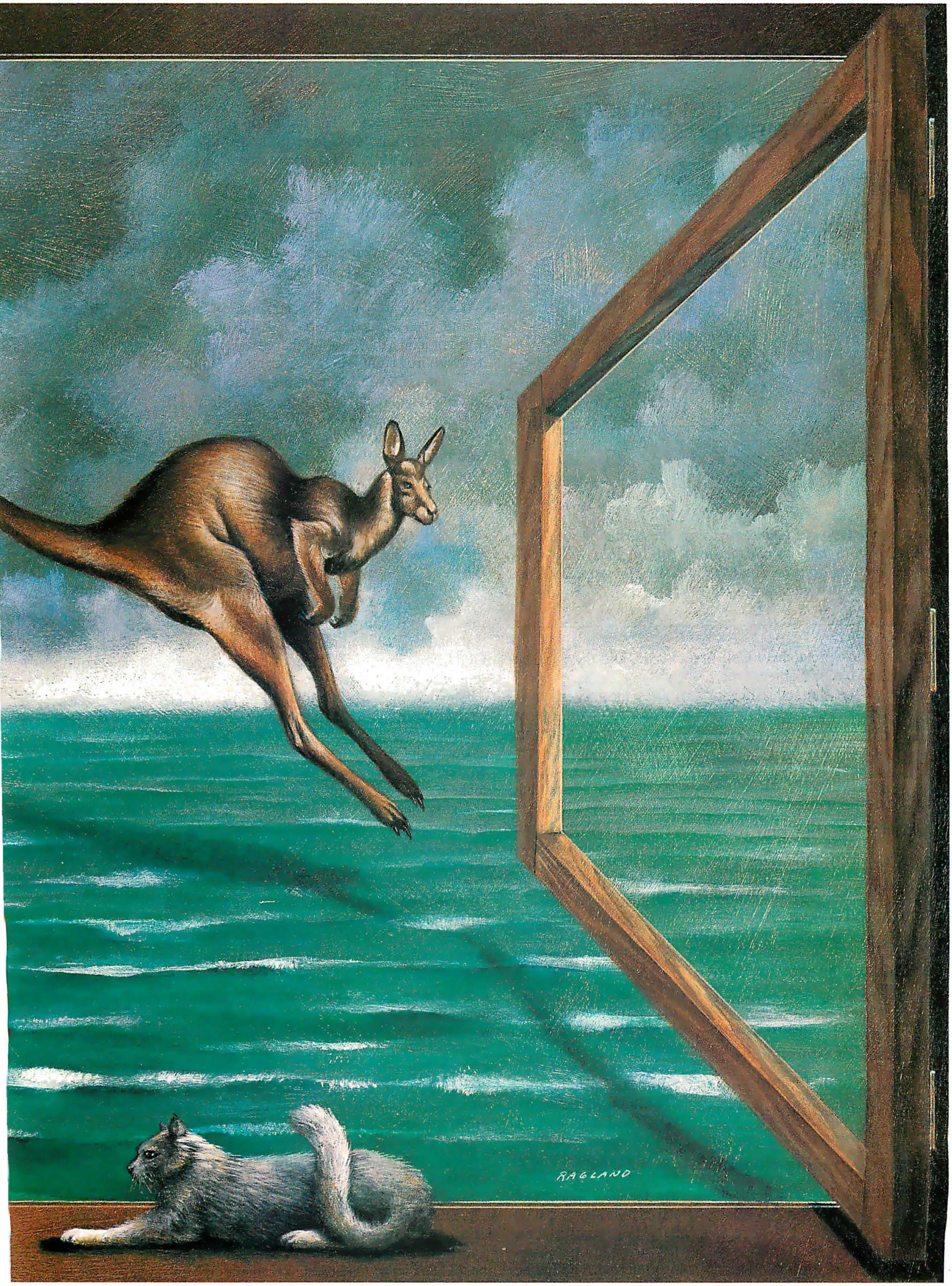


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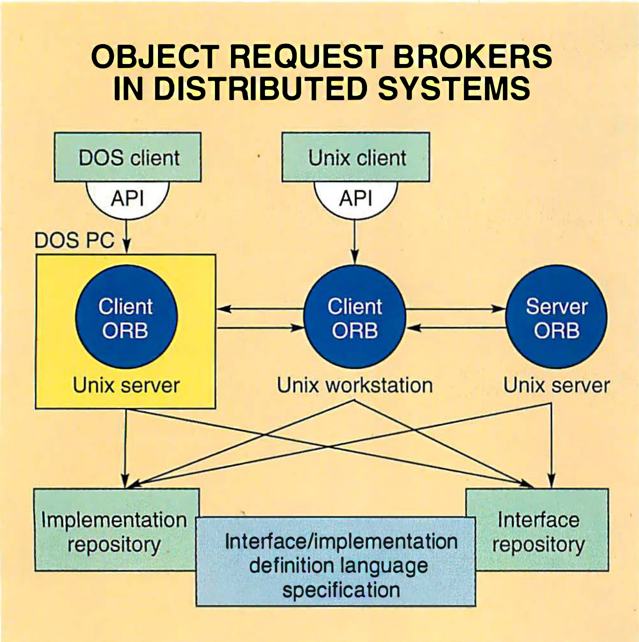


Figure 1: *The Object Request Broker is the kernel of a standardized DOMS and provides interoperability and reuse of a system's existing objects. The ORB enables client applications to access services and other objects that exist anywhere in the distributed system.*

belongs to the Spreadsheet Cell object type, and the wolf belongs to the Mammal object type.

Each type has characteristics, or attributes, associated with it along with the operations. For example, the Mammal type has certain attributes, such as circulatory system and skin type, while the Window type has other characteristics, such as menu bars, scroll bars, and up and down arrows.

Types are organized into a hierarchy that determines how operations and attributes are shared. Using the hierarchy, you can define a type broadly and then refine it into successively finer subtypes, each of which inherits the attributes and operations of its "supertype" and adds its own unique operations.

For example, Felines, Canines, and Marsupials are all subtypes of the Mammal type. These subtypes inherit the attributes and operations of Mammal. The Feline subtype adds its own unique operations, such as Purr and Retract Claws, while the Canine subtype adds others, such as Bark and Hunt in Packs. The ability to inherit attributes and operations greatly reduces repetition within designs and programs, and it is one of the main advantages of an object-oriented system.

BYTE ACTION SUMMARY

Pulling diverse systems and applications together and managing their communications require some form of mechanism. A distributed object management system provides a single interface to manage the complexities of a heterogeneous environment; a uniform framework, based on standards and extensibility, to build, integrate, and deploy open distributed-computing applications; and a method for creating location independence for client applications.

Today's Classifications

Object-oriented technology has provided three classifications of object-oriented systems that are in the marketplace today. They are object-oriented graphical user interfaces (OOGUIs), object-oriented databases (OODBs), and object-oriented programming languages (OOPLs).

OOGUIs are usually based on some metaphor from the real world, such as the desktop. The GUIs might include objects in the form of icons on a desktop that represent items contained in an office environment, such as a calendar, clock, wastebasket, and calculator. OOGUIs on the market today include the Macintosh interface, Microsoft Windows, OSF/Motif, DECwindows, Open Look, and others.

To perform actions, you select an icon with a mouse. The system then sends the icon operations, such as Move, Duplicate, Open, and Delete. These operations are separate from the actual icon itself and can operate on other icons (i.e., objects) in the system.

OODBs represent and manage objects and their attributes, relationships, and operations. OODBs also enable the creation of application-specific models of real-world constructs.

Complex systems that require actions among objects in the system's informational model may also find OODBs useful, as may systems with unstructured data requirements (e.g., voice, text, and video). Multiple applications can share these objects, and OODBs can provide many of the database facilities required (e.g., security, transactions, and recovery).

The driving force behind OOPLs is to make computers easier to use, more visual, more interactive, and easier to program. Translating applications specifications to actual code should be easier with OOPLs than it has traditionally been. Object-oriented modeling, designing, and programming provide the tools that make these goals easier to attain.

Using the object-oriented approach, you can model solutions to organization problems in a real-world way. Fewer trade-offs are necessary to accommodate systems, applications, and exceptions.

Distributed Object Management Systems

Pulling such diverse components together and managing their communications require some form of mechanism. Currently, each organization that produces and markets an OOGUI, OODB, or OOPL limits the number of platforms its object-oriented system operates on. In addition, these components usually don't interoperate with each other. A distributed object management system (DOMS) addresses this lack by providing the following:

- A single interface to manage the complexities of a heterogeneous environment
- A uniform framework, based on standards and extensibility, to build, integrate, and deploy open distributed-computing applications
- A method for creating location independence for client applications

A DOMS lets you build applications using a standardized interface while reusing the system's existing objects. With the advent of DOMSes, the Object Management Group (OMG; see the text box "The Object Management Group" on page 125) has

The Object Management Group

CHRISTOPHER M. STONE

The Object Management Group (OMG) is unique. Let's face it, trying to get computer technologists and marketers to agree to a set of rules for the future of software development before economic entrenchment dictates direction is an anomaly.

Object technology was born in the basements of R&D labs and has long had their altruistic outlook stamped on it. "Objectphobia" has been a disease in the ranks of middle and upper management in vendor and user organizations for years. Object technologists were the ones invited to present their views on the last day of the conference at 4:30 p.m.

Armed with logic, mathematics, and analogies only a chemistry teacher could love, object technology suffered from a basic problem in the computer industry—too many people of above-average intelligence trying to prove its worth. The computer industry suffers from the tenet that theology and metaphysics are the 1000 points of light and that the consumers, or people that spend money, are all test sites.

What Is the OMG?

The OMG is a technology-endorsement group, not a standards body. What we create may become de facto standards, but we are not accredited to enforce them. We don't sell software. We distribute a specification derived from commercially available technology that has been selected through an arduous, open, well-documented process in the hope that the membership and industry alike will clone it, develop to it, or buy source or binary code from an instance of it. In short, we set down rules for object technology that will make software development easier, reusable, modular, and high-quality.

Problems? Nothing evangelism won't cure. There is a fundamental problem found in any industry trying to lay down rules before money talks. The lack of applications interoperability is the problem. Period.

The OMG Role

There is widespread agreement that the OMG is trying to move an entire industry toward the development of interoperable applications. There is not, however, agreement as to how this is to be done.

Like any democratic forum, the OMG needs the support and commitment of its membership. And as in other computer trade groups, jockeying for position is a recreational sport. The vendor and user communities have begun to put their trust and support behind Open Software Foundation, X/Open, and Unix International. Object technology needs to be raised to that level.

Evidence: CORBA, Object Messaging

For the first time in the computer industry, the consensus on the early specification for a technology has become reality. Credit goes to Hewlett-Packard, Sun Microsystems, NCR, Object Design, DEC, and HyperDesk for reconciling what many had thought to be irreversibly warring factions—with the winners being the software development community.

Building the Common Object Request Broker Architecture (CORBA) by combining static binding with a dynamic application programming interface may appear to be like mixing OSF/1 and System V together, but at OMG there is the willingness to try. OMG's mission from Day 1 was to foster cooperation and create industry consensus in advance of the market. In doing so, interface specifications could be agreed to early on without economic pressure.

The Object Request Broker (ORB) is the most significant new approach to software standardization since consortium forming came into vogue a few years ago. The process of selection that is used at OMG, although it is not entirely without flaw, has demonstrated that technical merit can overcome bureaucracy.

In essence, the work is being completed as OMG is helping to solve many of the discrepancies among other consortia, as we define applications development environments onto the consortium-driven standards. The CORBA will be a fundamental enabling technology for distributed computing for independent software vendors, end users, and standards groups alike.

Next Step?

The next OMG test will involve the development of an object model that will describe the formalism of an object and its use in data management. There are academic and semicommercial object models everywhere that attempt to describe a specific function, such as managing devices in network management, but no single group has attempted to solve the whole problem: reaching an agreement on a data model with widespread applicability.

Just as we were confident that we could produce an ORB, we're confident that the OMG will produce an object model within the next six months. In addition, object services for languages, databases, document-content architectures, and windowing systems will also be starting shortly. Although we don't believe that this list of tasks can be completed in 12 months, it is the beginning of true sharing of libraries or objects among the development community and the eventual end user.

Detailed information concerning OMG membership, mission, and goals is available. Please contact Elizabeth Jewitt, Member Relations, OMG Headquarters, 492 Old Connecticut Path, Framingham, MA 01701, (508) 820-4300; fax (508) 820-4303.

Christopher M. Stone is president and a founder of the Object Management Group (Framingham, MA). Prior to the founding of OMG, he was group manager and director of software products at Data General. You can reach him on BIX c/o "editors."

sponsored the Object Request Broker. The ORB is the kernel of a standardized DOMS and provides interoperability (see figure 1).

The ORB enables client applications to seamlessly access services and other objects regardless of where they reside. To understand DOM more fully as the solution to open distributed computing, you need more technical details.

The Technical View

In its simplest definition, an object would be the specific case (or instance) of a generalized software template. This template is just a mechanism for describing some entity. Its form is open-ended, so it's extremely flexible.

When a template layout is defined in the system, it's called a *class*. When the fields within that template are filled in with specific information, that instance or instantiation of the class template is an *object*. Therefore, a class describes the set of specific implementations or instances called objects.

For the purposes of this article, I'll assume that a class template consists of a set of attributes and a set of methods. Attributes can be simple data items like integers or character strings, or much more complex data like files (in these cases, the attributes are pointers to those items).

The methods can be anything from compiled subroutines written in a conventional programming language like C to code written in interpretive languages, or even to shell scripts. When these template fields are filled in with specific data, the template becomes an object.

The ORB and DOM

The ORB represents the core of DOM. It can be viewed as a network operating system with one basic command, EXECUTE. The format of this command would be something like `EXECUTE [object_name, method, parameter1, parameter2, ..., parameterN]`.

The job of the ORB is to locate the named template (the object), start the specified operation (the method), and pass it the parameters it needs. Since objects can exist anywhere on a network, you can locate them via a name service or a unique identifier—a *handle*.

The ORB also needs to provide other capabilities associated with object-oriented systems. While these concepts have fancy names (e.g., subclassing, inheritance, and polymorphism), they are simple to understand in the context of the software class templates.

Subclassing is when you tell the system to make a copy of a template but give it another name. You can revise the behavior of any of the copied (i.e., inherited) methods and then add some new methods and attributes of your own; this is called *specialization*.

In specializing a template, you create a new version of the class—it is similar to the original class but different. It lets you take advantage of something previously developed, possibly for a different purpose, and modify it to suit the new function. This mechanism provides the reusability benefits of object orientation and promotes cost-effective software systems that are easier to develop, maintain, and enhance.

A variation on this theme is to substitute a different method but with the same name as one in the original template. Since methods are invoked by name, this allows you to leave your application unchanged yet still receive the benefits of the modification. This process is known as *overriding*.

The ability to override allows you to maintain a consistent interface while hiding the differences in implementation. This capability is called *polymorphism*.

Any object-based system needs to support these capabilities, as well as an ORB. So how are they provided? Simply by including some primitive (root) templates (base classes) as part of the basic ORB. Built into these base classes are methods that provide the functionality of subclassing, inheritance, and polymorphism. In other words, you would use a command line like `EXECUTE [base_class_name, subclass_method, parameter1= new_class_name, ...]`.

Using the same EXECUTE command to invoke the subclass or substitute method now provides basic object-oriented functions. In fact, by adding more of these intrinsic operations to the base classes, you can continue to enhance the system's capabilities and make them available through the same simple interface mechanism.

These built-in objects are predefined classes, or templates, manipulated by the same basic interface. Since you can change or replace these classes, even the system's basic capabilities can be modified and extended.

This ability raises a couple of interesting questions:

1. If the base classes provide the basic object-oriented functionality and the ability to create, inherit, and override classes and objects, how do you create the base classes in the first place?

Have a bootstrap process that loads an initial set of classes. This process exists and is easy to use with something called the Interface/Implementation Definition Language compiler.

2. If you can redefine the system's basic functionality, how do you maintain compatibility?

Develop a standard for these basic functions and classes (the role the OMG is expected to play). The base classes and their object life-cycle methods are known as a *type repository*. For compatibility and true interoperability among different implementations of an ORB, a standard for these classes and methods must be created.

Dynamic Integration

So now you have a mechanism for wrapping (or encapsulating) a template around any collection of data (attributes) and programs (methods) and treating it as a manageable entity called an object. And you have the first definition of a specific template format called a class, and all implementations of that template (with specific data and code filled in) called instances, or objects, of that class.

Data can be simple numbers or complex bit maps. Code can be compiled language modules (e.g., C) or interpreted scripts.

Objects have names and can be anywhere on a network using a name service. You can build complex client-server applications by creating servers that these templates describe, and clients can access these services by invoking their methods through the ORB.

If you build applications in this manner, you can move the pieces around easily, make changes to services without affecting the clients, prototype using files and scripts, and replace them with more efficient implementations using compiled code.

In addition, if you develop a class template, you should be able to modify or add new code without bringing the system down or affecting already-running applications. This is known as *dynamism*.

The system should be able to select which of multiple methods (with the same name) to use based on user preferences (whatever machine you're running on that day, language preferences, and other cultural or system preferences). This is referred to as *context-sensitive method binding*.

You (or the client application) should be able to ask the object to describe itself—its methods, the parameters required, and its attributes. Thus, by exploration, new capabilities and services can be discovered and used at run time. This is a capability of dy-

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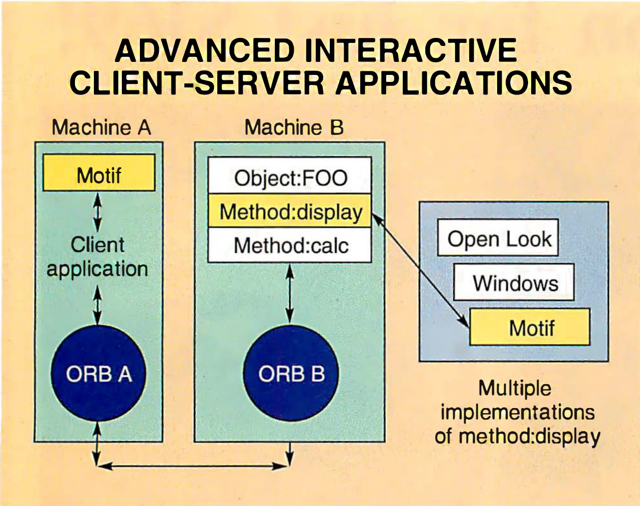


Figure 2: *In this example of a client-server application, a client application is running on one CPU and operating system (machine A), with some additional object services (in this case, calculations) running on a different machine (machine B). The client application has discovered the object handle of object FOO. The implementation of FOO resides on machine B, and the calc operation is available for it. The client application issues a request to FOO for operation calc. The ORB on machine A routes the request to the ORB on machine B, which selects the correct method and returns the results to the client application. Next, the client application issues a display request for FOO, which is automatically routed to machine B, where the local ORB determines the display method required for display of FOO on machine A and returns the appropriate file to machine A for execution.*

namism. And finally, all this software should be portable across different hardware, operating systems, and networks.

DOM Examples

Object queries: Data-intensive applications (e.g., typical commercial on-line or database applications) require efficient query mechanisms to retrieve attribute information about a particular object or about every object in a group. Since the object types in a system must be able to change dynamically, the DOMS supports a query mechanism.

The DOMS's query mechanisms let you specify the attributes desired at run time instead of having to code their names into procedure calls. For example, if there are 50 objects of a certain type and the application needs five attributes from each object, one dynamically constructed DOMS survey call will return all the data.

Legacy expansion: DOMSes should at least provide mechanisms for building new applications. In addition, they should provide a mechanism for integrating previously existing applications and data. The encapsulation of existing applications and data as objects is known as *legacy expansion*.

One way to provide this functionality is through an encapsulation facility that uses interpreted scripts and languages. You need not write and compile code to encapsulate existing applications.

"User-centric" applications: Interactive, graphical application environments let you customize and adapt the software without programmer intervention. Such environments support incremental learning, discovery, change, and growth. This capability will be required in future advanced desktops, office-automation systems, and workgroup applications.

The system must be able to accept modifications and the creation of "meta-applications" built of component objects without affecting either the client code or its own ability to remain operational during the changes. Yet the system must also protect all objects and prevent or restrict changes if security so dictates.

The ability to support user-centric applications is what differentiates a platform capable of dynamic operation from one that implements a CORBA (Common Object Request Broker Architecture)-compliant dynamic invocation to static functionality. The HyperDesk DOMS provides both dynamic invocation and dynamic operation.

Advanced interactive client-server applications: Applications need the ability to operate across a diverse mix of hardware and software platforms. For example, in figure 2, a client application is running on a particular CPU and operating system (e.g., a Sun Sparcstation with SunOS and Motif) with some object services (maybe a CAD object) running on a different machine (e.g., a Cray supercomputer). This type of applications architecture requires calculation services from objects and mechanisms to display the results of those calculations.

Using a DOMS, it's easy to separate the object's operations into those that are display-independent and those that are display-dependent. Moreover, once this separation is made, the system's knowledge of the client context makes it possible for the ORB to select the correct display method. This eliminates the need to write environment-specific code.

In this example, the ORB determines that the appropriate display method is for the Motif environment on machine A and returns a Motif user-interface-description file to machine A for execution. The class-definition object can have multiple display methods stored with it. For instance, it can have one for each display environment (e.g., Motif, Open Look, and Microsoft Windows).

Software Without Walls

To create the type of open distributed computing described here, you need a complete DOMS with an advanced suite of tools and services that complements an OMG-compliant ORB. A complete DOMS bridges the operating-system, applications system, and communications protocol void that exists today and enables you to bring applications and systems together into a cohesive unit.

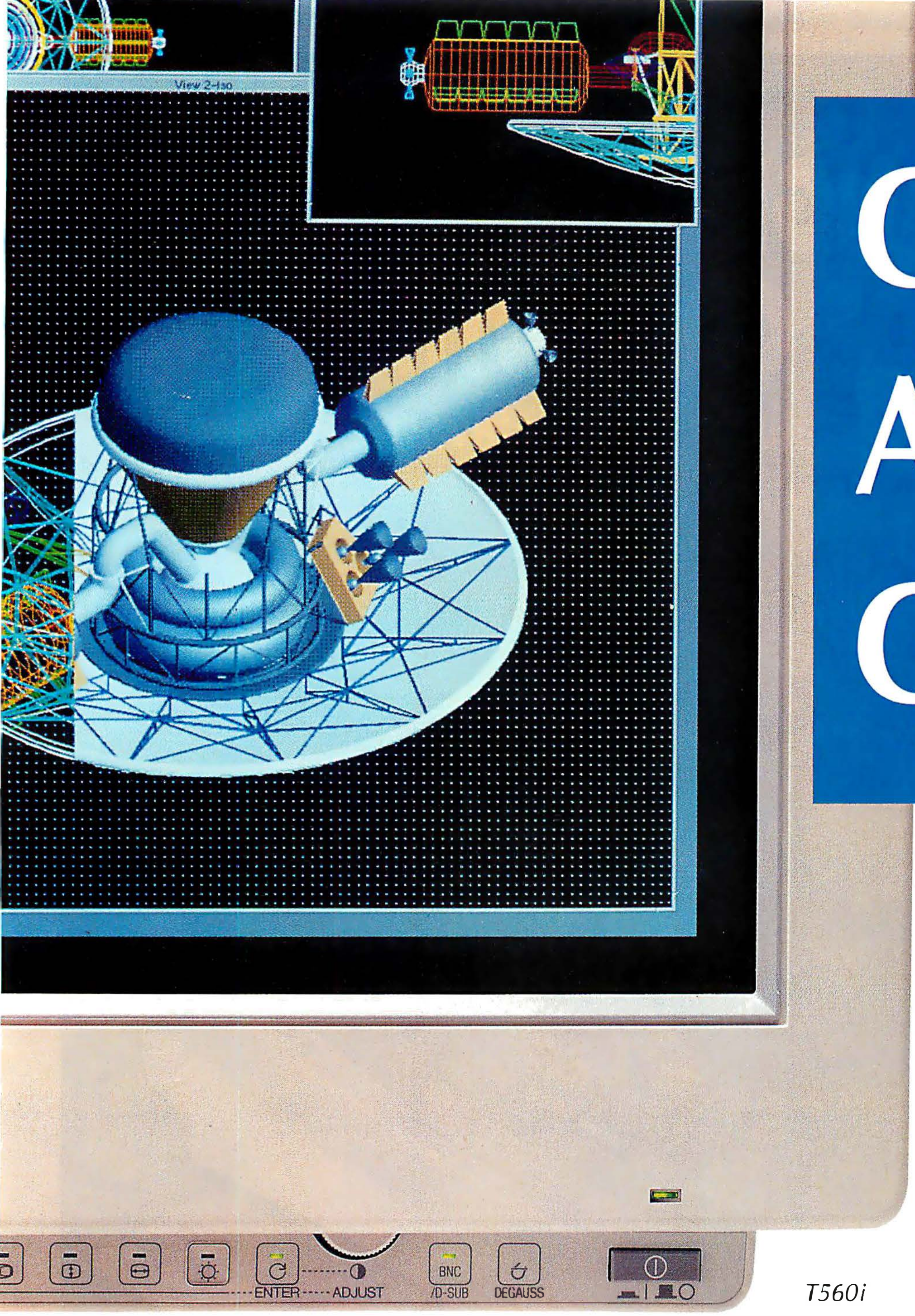
Some of the advantages of a complete DOMS are as follows:

- Your organization can retain its existing hardware and software assets while integrating new applications and solutions easily and seamlessly.
- You can take advantage of the extensibility and reusability of objects to cut down development time and deliver distributed applications more easily.
- You can integrate existing applications economically. Even large legacy applications written in COBOL or FORTRAN can be encapsulated within a single object, preserving past software investments.

With DOM, building and integrating open distributed applications is practical. You can gain simplified access to information, wherever it is—giving your company a competitive advantage. Software without walls is no longer a promise; it's a reality. ■

Herbert M. Osher is president of HyperDesk Corp. (Westborough, MA), which develops distributed-computing software based on object management technology. You can reach him on BIX c/o "editors."

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FEATURE

System Bus or System Bottleneck?

Whatever happened to EISA and the Micro Channel?

TREVOR MARSHALL

IBM has taught us that compatibility is the single most important attribute for a mass-market bus. Without compatibility, there is no incentive to produce the innovative, third-party peripherals that have largely determined what we can expect for today's personal computers.

The second most significant characteristic is speed. The bus must be fast enough to transfer data from modern high-speed peripherals to the host CPU with no noticeable degradation in system performance.

The original IBM XT was shipped with a very limited 8-bit expansion bus. It was not long before add-in cards started to tax its capabilities, so, with the release of the IBM AT, this 8-bit bus was widened to 16 bits and increased functionality was added. This created a clumsy (but standard) protocol now dubbed Industry Standard Architecture (ISA).

Four years ago, IBM announced with great fanfare that it had created the most advanced bus a desktop computer would ever need. It was called the *Micro Channel*. Soon after, a consortium of IBM competitors announced its own "perfect" bus, dubbed EISA (for Extended ISA). Both of these buses were claimed to be extensible, to have much higher performance than ISA, and to be its obvious successor.

Yet despite the claims (and hopes) of both EISA and Micro Channel promoters, neither architecture has managed to take a significant share of the market. Less than 5 percent of PC-compatible machines sold worldwide use the EISA bus. The remainder are mostly still ISA (AT-bus) compatibles. The Micro Channel has made an impact, but primarily in applications where bus speed is not a factor, such as point-of-sale terminals and data-entry stations. Consequently, the volume of Micro Channel add-in boards sold is still small.

Mastering the Buses

The XT bus was designed to complement a 4.77-MHz 8088 processor. It did that job well, delivering adequate transfer speeds for the add-in adapters of that day.

By the time the AT was released, it was becoming evident that microcomputers were soon going to catch up with the performance of the minicomputers and mainframes that still dominated computing. Consequently, the designers of the AT enhanced the XT bus by adding more DMA channels, more interrupts, and, most important, a 16-bit data bus. And they did this while retaining downward compatibility with the XT bus.

The AT bus proved adequate for the types of add-in adapters needed to complement the performance of an AT-class machine. The bus structure was reverse-engineered, multisourced, and dubbed the ISA bus.

Both the Micro Channel and EISA designers sought to overcome some of the limitations remaining in the ISA design. First, they provided a 32-bit data path to match the newly emerging 32-bit processors, such as the 386 and 486. Second, they paid a lot of attention to increasing the data transfer rates by more tightly specifying the bus transfer protocols. Third, they gave both buses considerable capability to support multiple bus masters.

A bus master is another, usually peripheral, processor that plugs into the bus yet can access the host processor's memory and usually all the system peripherals as well. You need bus-master capability if your system is going to support intelligent drive controllers, such as those used in high-end

BYTE ACTION SUMMARY

What does bus mastering have to do with EISA and the Micro Channel? A bus master supports intelligent drive controllers, image-processing functions, and a host of other leading-edge applications. It can transfer data from a peripheral card without affecting the CPU control program. EISA and Micro Channel both permit such concurrent processing;

Signals on the Wire

A transmission line is a wire down which a signal from the CPU propagates to a peripheral. The simplest case, where only resistive terminating elements exist, is shown in figure A (see reference 1).

A 5-volt source with a series damping resistance of $Z_0/4$ ohms (Z_0 is the characteristic impedance, typical of most printed circuit board conductors) feeds the bus wiring. A typical Z_0 on a printed circuit board is 50 to 150 ohms (see reference 2). The peripheral terminates the bus with an effective resistance of $5 \times Z_0$ ohms.

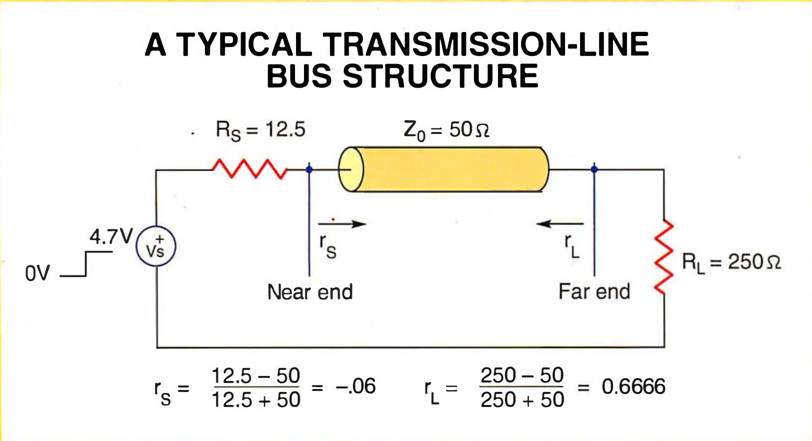


Figure A: *The electrical model of what seems like a simple line of copper on a circuit board. The input signal (in this case, a typical 0- to 4.7-V logic transition) is modeled as the voltage source (V_s) for the transmission line. It must drive not only the relatively docile loads of pure resistance (R_s, the source resistance, and R_L, the load resistance) but also the more difficult reactive components Z_O (characteristic impedance of the transmission line), r_L (normalized impedance of the load), and r_s (normalized source impedance).*

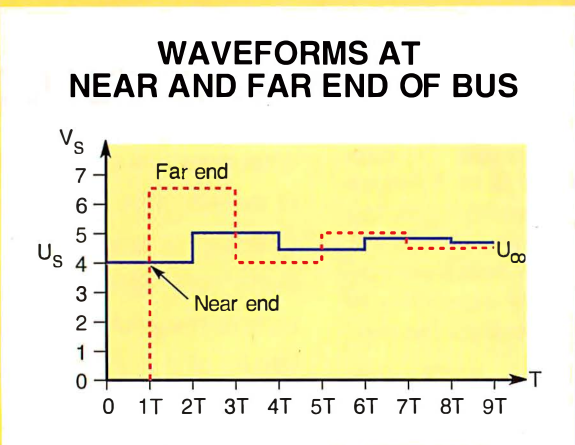


Figure B: *A logic transition occurs at the near end of a bus at time 0 and arrives at the far end at 1T, with significant overshoot. The overshoot propagates back to the near end and changes the voltage there. The reflections travel up and down, decreasing, until at 8T the bus settles near its final logic level.*

Due to the loss in these resistances, only 4.7 V of the 5-V TTL high level that the CPU generates will be available to drive the peripheral. Because of signal reflection, you can't decrease the series resistance to transfer more energy along the bus.

Consider an 8-inch bus. When the CPU's signal reaches its far end, some of the energy is reflected to the source, giving rise to a theoretical waveform (see figure B). The voltage on the bus oscillates around the final value. If the oscillation grows too great, it exceeds the threshold value at which a logic device (e.g., a bus receiver) is triggered to change state. The receiver may then change its output value based on a false input generated by circuit ringing. Usually, the circuitry will fail to work properly, but sometimes the system can read the false value as a valid bit. In the real world, there is capacitance, not just pure resistance, to drive.

Figure C is an early ISA clone's system clock (pin AXX) measured at the end of the bus. The signal badly overshoots the 0-V level and, in fact, reaches a negative voltage of about –3 V. Then the signal "rings" back to a level of about 0.8 V, causing most logic gates to malfunction.

On the positive transition, almost no overshoot occurs, although the peak voltage is only 3 V—much less than the theoretical 5-V maximum. The difference is due to an asymmetrical driving impedance.

The designer of the bus in figure C mistakenly used a very fast buffer device (a 74F245) to drive the clock

network servers. It is also useful in many industrial applications, such as image grabbing and image processing.

The ISA bus can only support bus masters if they are set up as DMA controllers. This limits the data throughput to around 1.5 MBps. In addition, the host CPU is usually halted during any bus-master transaction.

A bus master should be able to, for example, transfer data from another peripheral card without affecting the control program running on the host CPU. EISA and Micro Channel both permit such concurrent processing; ISA does not.

Speed Limits on Buses

The speed of light limits how fast signals can propagate down a bus structure. But today's buses operate nowhere near this

CLOCK WAVEFORM FROM A POOR PC CLONE

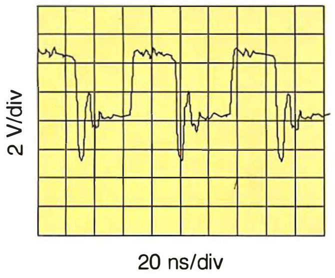


Figure C: *This oscillograph is taken from an early ISA clone. It shows the system clock (pin AXX) measured at the end of the bus and severe overshoot.*

directly, without any series-damping resistor. The output impedance of this buffer (which should be greater than $Z_0/2$ to control overshoot) is extremely low when the signal goes from high to low (the *pull down* cycle) but fairly high when the signal goes from low to high (the *pull up* cycle).

If a slower logic gate had been used, the designer would have achieved faster system operation overall, less overshoot would have occurred, and the final voltage would have been achieved more quickly. This is what happens on the positive side, which is only half as fast as the negative. On the negative side, the signal achieves the steady-state level almost instantaneously.

The oscilloscope time base was set for one horizontal divison every 20 nanoseconds with the CPU speed at 50 MHz. So, here is a bus where one handshake transaction would make a modern CPU wait almost a full cycle for it to complete. ISA, Micro Channel, and EISA buses require at least three transactions in every bus transfer cycle.

In an optimally designed system, these transactions occur much faster. Parts 1 and 2 of figure D are taken from a Mac IIfx NuBus. Part 1 was taken at the far end of the bus, with two cards (the test card and a video card) plugged in. A little overshoot exists, but not enough to cause logic to malfunction. The rise and fall times of the signals are fast, and the ultimate signal levels are close to 0 and 5 V. The two signals shown are the system clock and start.

Part 2 was taken under the same conditions, but this time with every bus slot filled. The extra loading that the four additional peripheral cards impose has reduced the rise and fall times, and the overshoot and settling are insignificant compared to transition times. This performance is typical of a bus designed using today's best technology.

So, the fastest time in which a transaction can occur seems to be 10 ns; 20 ns would be safe. So you can expect an ISA, EISA, or Micro Channel bus to manage one transaction every 30 to 60 ns using interface chips like the IIfx's. Thus, even the fastest bus transaction will take between one and two instruction cycles on a 33-MHz CPU.

MAC IIFX NUBUS OSCILLOGRAPHS

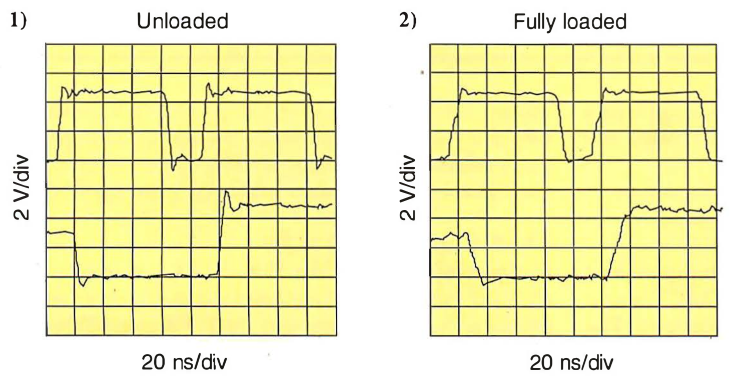


Figure D: **(1)** *An oscillograph taken at the far end of a Mac IIfx NuBus, with just two cards (the test card and the video card) plugged in. A small amount of overshoot is present, but not enough to cause logic to malfunction. The rise and fall times of the signals are quite fast, and the ultimate signal levels are very close to 0 and 5 V.* **(2)** *Another measurement from the far end of a Mac IIfx NuBus—but this time every slot on the bus has been filled. The rise and fall times have now been reduced by the extra loading of the four additional peripheral cards, and the overshoot and settling are insignificant compared to the transition times. This performance is typical of a bus designed using the best technology available today.*

Editor's note: *All oscillographs reproduced here are 20 ns per division horizontally and 2 V per division vertically. Equipment used for testing bus signals was as follows: oscilloscope—500-megasample-per-second Fluke digital scope; probes—100x resistive probes, 1500-MHz bandwidth, Philips PM8912.*

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2. Jordan, Edward, ed. *Reference Data for Engineers: Radio, Electronics, Computer, and Communications*, 5th ed., pp. 22–25. Indianapolis: Howard Sams, 1985.

fundamental limit, do they? On the contrary.

An electrical signal travels down a *perfect* bus at about 7.86 inches per nanosecond. A 33-MHz CPU executes instructions as fast as one every 30 ns. Thus, if this CPU sent out a request on a perfect bus to a perfect peripheral, you would lose one complete computational cycle for every 20 feet the signal had to travel. Naturally, in our *imperfect* world, things are much worse. To comprehend the fundamental performance limits for buses, you need to understand something about transmission-line theory (see the text box "Signals on the Wire" on page 132).

Since bus physics fundamentally limits bus speed, the only easy way to improve the data transfer speed is to increase the width of the data bus (i.e., the number of data bits that can be exchanged for each set of bus transactions) or decrease its length.

continued

Compatible May Not Mean Easy

I recently tried to install one of the new low-cost fax-modem cards into a Hewlett-Packard 486 EISA-based computer. The EISA bus is compatible with ISA, right? So you just plug in the ISA card and it should work, right? Wrong.

I plugged in the fax card and installed the BitFax software as described in the manual. When I ran the program, it informed me that no fax card was present.

A check of the manual showed that all the DIP switches were set correctly for COM3, so there shouldn't have been any clash with the hardware already installed in the computer. Then inspiration struck me. I remembered seeing a press release about EISA doing away with the need for "complex" DIP switches and replacing them with a setup program. Referring to the HP manual confirmed that the EISA machine would not recognize the ISA add-in card until it had been "installed" and that I would need an Adapter Configuration File from the add-in's manufacturer before the EISA bus could recognize the fax card.

I borrowed a copy of the EISA Programmers Reference Manual from HP and, over the course of an hour or so, learned yet another programming language, wrote the Adapter Configuration File, and got the fax card up and running. A call to HP technical support later revealed that HP could send me a file containing a set of common adapter descriptions. If a card is sufficiently similar to a "common" adapter, then that file would have worked.

But why? Why couldn't I just plug the card in and have it work?

From day 1 of the IBM announcements, I had fully understood the proprietary nature of the Micro Channel bus. It was obvious that if I chose to go the Micro Channel path to higher performance, I would have to buy specialized adapter cards, there would be fewer sources for them, and they would be more expensive. But I never anticipated that EISA would have similar barriers to the free-market economics that have made personal computer technology such a success.

Luckily, now that third-party (clone) vendors are starting to ship EISA machines, software has been written to ease the installation task. Most clones now ship with installation software that scans the bus, looking for I/O ports and memory maps that it recognizes, like the COM ports on a fax adapter. If you have a nonstandard peripheral, however, you are still out of luck.

With today's driver technology, a 32-bit bus can achieve a data rate of about 60 MBps, a 16-bit bus can reach about 30 MBps, and an 8-bit bus can attain about 15 MBps.

The PCXI Consortium has been formed to define a variant of the EISA bus that is better able to serve the needs of scientific, engineering, industrial, and other power users. It has extra undefined pins capable of carrying signals between cards on high-speed local buses. These pins can also be used to carry Data Translation's (Marlborough, MA) DT-Connect bus architecture. The DT-Connect bus can transfer data at a rate of 100 MBps using standard 74FCT bus-driver ICs.

Bursts and Streams

To reduce the number of signal transactions needed per data transfer, you would use so-called *burst* or *streaming* data modes. The data rates that the Micro Channel and EISA promoters quote, 40 MBps and 33 MBps respectively, are possible only with data streaming.

The problem is that for data streaming, the data needs to be of a continuous nature. Data from a drive controller is often continuous. But the speed of data being sent to a video card is more likely to be determined by CPU processing speed, and the data's transfer is usually performed in the slower single-transaction modes.

For example, a typical 8-bit ISA bus achieves a data rate of only about 1 MBps in practice—10 percent of the theoretical maximum. Its primary limitations are the response time of the cards in the bus and the nature of the motherboard logic, which uses wait states to slow down the bus to synchronize with its own internal response times. These limitations apply equally to wider buses and to EISA and Micro Channel implementations.

I recently checked the relative speeds of a 16-bit Ethernet adapter card and an 8-bit version of the same product. The 16-bit card provided only a 20 percent performance improvement. You don't need to use an advanced EISA system when the primary limitations are still processor- and network-related.

The Compatibility Factor

Compatibility among the ISA, EISA, and Micro Channel systems implies, at least, that software designed to run on ISA machines will run the same way on EISA and Micro Channel systems. By and large, this has proved to be true.

In addition, compatibility implies that you can expect hardware designed for the Micro Channel to run in any Micro Channel machine and, similarly, EISA-designed hardware should run in any EISA machine. EISA promoters also claim that ISA adapter cards will run in an EISA machine (see the text box "Compatible May Not Mean Easy" above).

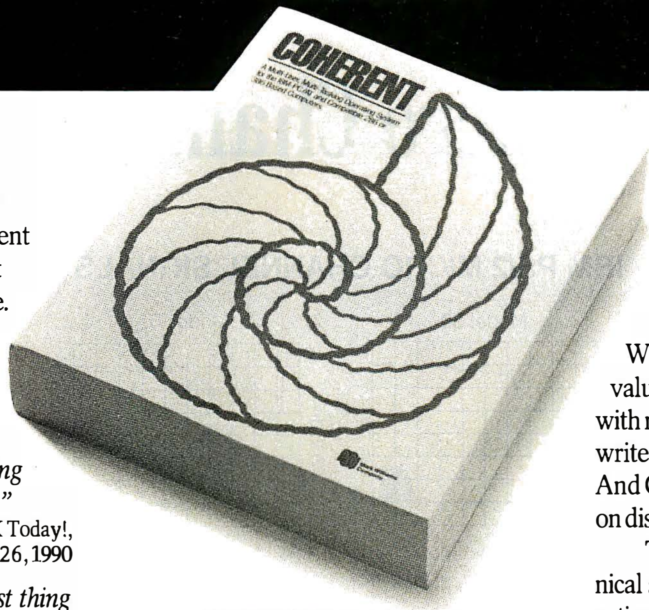
However, some problems have occurred that have delayed achieving compatibility within Micro Channel systems. The early interface chip from Chips & Technologies (the 6311) worked fine in the IBM PS/2 Model 50, but it did not work well with the later Models 70 and 80 because the IOCHRDY signal operated incorrectly (see the text box "Which Micro Channel Is It?" on page 136).

Thus, some manufacturers who embraced the Micro Channel early in its development had to redesign their Micro Channel products at an early stage in their life cycle. Not only did this reduce the number of available adapters, it also increased their cost. But these early problems have been overcome, and both Micro Channel and EISA have now achieved the levels of hardware compatibility expected of them.

However, with the RISC System/6000 series of RISC workstations, IBM introduced a Micro Channel with a larger physical

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Which Micro Channel Is It?

Not all Micro Channel implementations are the same, even when they are from IBM. Figure A shows two oscillographs; part 1 was taken from an IBM PS/2 Model 50, and part 2 from an IBM PS/2 Model 70. The two waveforms, ADL (Address Latch) and CMD (Command), are supposed to delineate two different phases of the transaction cycle.

Notice that on the Model 50 the waveforms actually overlap. While the same waveforms on the Model 70 look more like the data book says they should, the quality of the signals on this bus is still nowhere near as good as those on the Mac IIfx's NuBus (see the text box "Signals on the Wire" on page 132).

Peripheral designers have to design cards that will work in all machines, both slow and fast. The only way to ensure this compatibility is to avoid the use of the advanced features that are available only on faster bus implementations.

Therefore, an add-in card designer has to use logic slow enough to accommodate the timing variations seen on the Model 50, instead of designing a card that will be upgradable to the 160-MBps peak Micro Channel data rate.

For the RISC System/6000 series of workstations, IBM introduced another version of the Micro Channel architecture, this one allowing for the use of larger option cards. The workstation version of the Micro Channel began as a 32-bit-wide bus, but there are plans to upgrade it to a 64-bit-wide revision supporting block transfers.

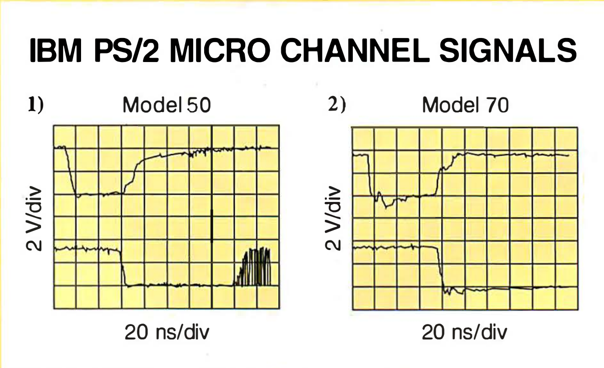


Figure A: *(1) is from a bus measurement in an IBM PS/2 Model 50, and (2) is from a test of an IBM PS/2 Model 70. The two waveforms represent measurements of the address strobe (upper trace) and command strobe (lower trace) lines and are supposed to show two distinct phases of the transaction cycle. Notice that on the Model 50 the lines actually overlap, causing a period of uncertainty that add-in card manufacturers can handle by building in bus-settling delays when designing Micro Channel cards. While the same waveforms on the Model 70 look more as they should, the quality of the signals on this bus is still nowhere near as good as that of those measured on the NuBus of the Mac IIfx.*

card size (it is now almost as big as an AT ISA card) and new, higher-speed, burst-transfer modes. So is the Micro Channel add-in you are buying PS/2 Micro Channel–compatible or RS/6000 Micro Channel–compatible?

Why Buy ISA Machines Now?

EISA and Micro Channel machines are still considerably more expensive than their ISA counterparts. Part of this difference is due to how much the EISA chip set costs the computer manufacturer. The other part is due to a recognition that an EISA machine won't sell as well as an ISA system will. In addition, only Intel currently ships an EISA interface chip. It is expensive compared to the ISA chips, which are available from a number of vendors.

In return for the higher price of the EISA and Micro Channel systems, greater levels of system performance are expected. But in actual use, this expectation has often not been met. Meanwhile, many designers have found a better way of increasing system speed: close coupling.

Close Coupling

RAM is the most speed-critical resource that a CPU needs. To improve system speed and bypass bus limitations, you can closely couple the main memory system to the CPU over its own dedicated bus.

Although the original XT had only 64K bytes of closely coupled (motherboard) memory and needed add-in memory cards to run any significant software, most computer systems sold today have several megabytes of high-speed, closely coupled memory on the motherboard. Add-in memory cards are rarely needed. Thus, bus-speed limitations no longer affect the CPU's ability to obtain data quickly from its main memory.

Local Intelligence

The same design methodology is now being applied to all the subsystems that make up a computer system. Vendors often claim that you need a fast bus for faster video (for applications such as multimedia). But as Nick Baran warned (see "The Bus Stops Here," February 1990 BYTE), none of these expansion buses really has enough raw bandwidth to directly transfer pixels at the rates needed for real-time video displays.

Peripherals need more local intelligence to off-load some of the host CPU's computing tasks. This is already happening in two areas: drive controllers and video display cards. The data rate of the ISA bus is slower than that of many modern hard disk systems. However, if you mount a memory cache on the drive controller, it acts as a buffer between the disk data rate and the bus data rate.

Even though the disk speed of the original AT computers was limited to around 260 KBps (the 2-to-1 interleave data rate), most controllers now operate at the 500-KBps rate of 1-to-1 interleave disks. The data from a whole track is stored in memory on the drive controller. It is then available when the host CPU is

SYSTEM BUS OR SYSTEM BOTTLENECK?

ready to use it. This architecture doubles system performance without needing any changes in the bus itself.

Enter Localbus

Intel has defined a bus for closely coupling peripherals to the CPU. Called *Localbus*, it essentially connects peripherals directly to CPU control lines. Similar connections to VGA controller chips have yielded a significant performance improvement over the same VGA chips on either EISA or Micro Channel adapter cards.

True, there is a limit to the number of peripherals you can connect through the Localbus. However, that limit is now mainly the limit of capacitive loading. Placing the Localbus chips on the motherboard very close to the CPU has reduced the inductive (transmission-line) component.

Moving beyond Localbus performance, CPU technology is migrating toward the "PC on a chip." In that vein, the CPU is incorporating more and more of the key peripherals into itself.

High-Speed RISC Connections

RISC processors are already operating at 50-MHz and 60-MHz clock rates, requiring efficient connections between the CPU and memory and between the CPU and peripherals. The SPARC Consortium has defined a bus, called *MBus*, that is very similar to Localbus and incorporates several important innovations likely to be seen in the very near future.

First, the MBus emphasizes the use of surface-mount technology to achieve small size and, hence, low parasitic inductance and capacitance. Thus, the bus never really becomes a "transmission line" (for electrically oriented readers, it behaves more like distributed lumped capacitors). The maximum card size is less than 20 percent of that of a standard AT expansion card, yet, by using smaller (surface-mount) components, it has basically the same functionality.

Second, the MBus uses a wider data transfer width: 64 bits. Since the bus can operate at 40 MHz, the useful bandwidth is 80 MBps, and the peak rate is 320 MBps.

Third, you can stack multiple MBus modules. Unlike ISA, EISA, and Micro Channel buses, the MBus modules are very close together, and very close to the CPU. Thus, although transmission-line effects definitely exist, the ringing and other artifacts occur at much higher frequencies and don't affect overall system performance.

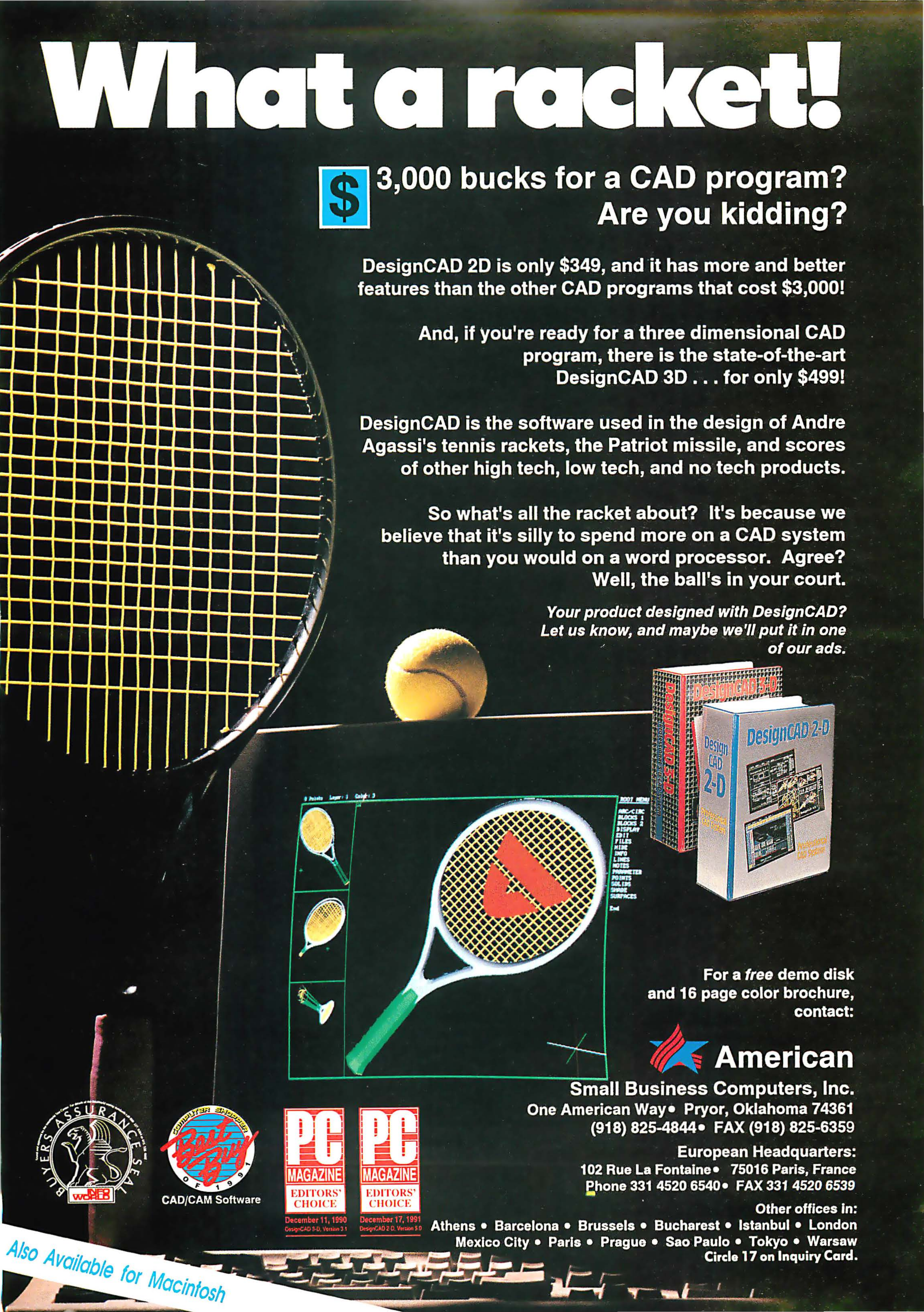
The Bottom Line

If you're planning to buy a Micro Channel machine today based on its promise of extensibility to 160 MBps, forget it. The Micro Channel may support that data rate one day, but just as you had to upgrade your CPU from 8086 to 286 to 386 to 486 to get their advantages, you will have to upgrade your system and peripherals to get that sort of data rate.

The same situation pertains to ISA or EISA. Until all manufacturers design their machines using the best technology available, the peripheral vendor will have to compromise, thus limiting the performance your system can achieve. Manufacturers are offering a lot of innovative solutions to overcome these limitations. Unless you are running a Unix or NetOS-based network (which needs blinding speeds from the drive controller), then ISA-based machines using Localbus technologies will probably do the job.

Select a system that does what you want today. The industry will provide brand-new products to choose from tomorrow. ■

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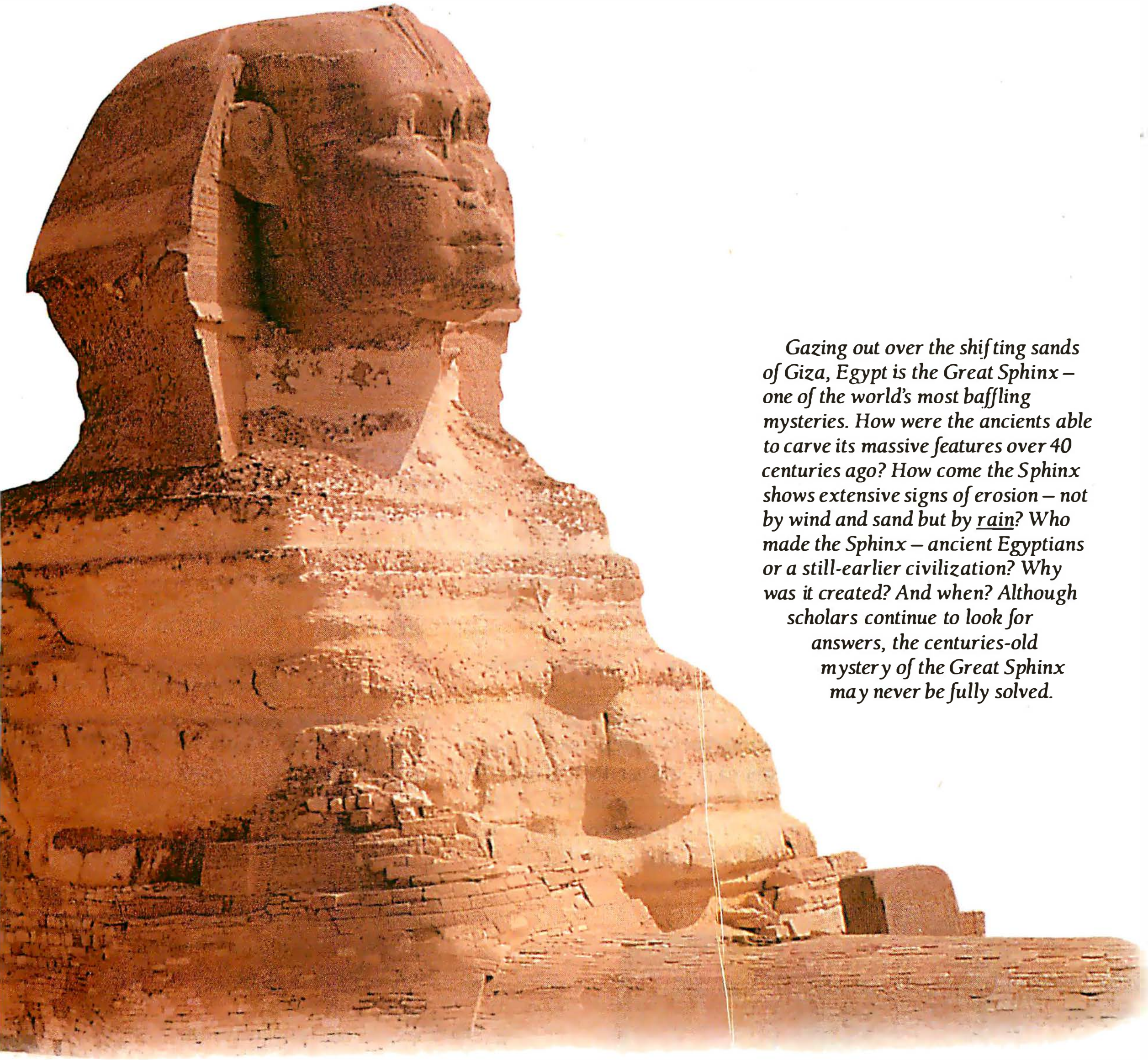
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FEATURE

The Birth of the Microprocessor

An invention of major social and technological impact reaches its twentieth birthday

FEDERICO FAGGIN

There are turning points in the history of technology when something new and major happens. Something unstoppable and irreversible arises (e.g., the automobile, the airplane, or the microprocessor) that becomes the catalyst for sweeping social and technological changes.

Such inventions don't come from new scientific principles but from the synthesis of existing principles. The new form expands the previous one in both predictable and unpredictable ways. Typically, the unexpected consequences are the most valuable.

Such inventions are frequently born out of a few believers' struggle with those who have something to lose from change, set in a background of indifference. Because these inventions have a certain inevitability about them, the real contribution lies in making them work.

You have to believe in the idea passionately enough to carry on the struggle, until it is firmly rooted in the world and has a life of its own. It is a work of intellect and love. On the twentieth anniversary of the introduction of the first microprocessor, the 4004, I would like to tell you the story of the early years.

In the Beginning

In 1969, Silicon Valley was the center of the semiconductor industry, and one-year-old Intel was one of the most prestigious spin-offs from Fairchild Semiconductor. Intel and a few other companies envisioned that semiconductor memories were the wave of the future and would replace the magnetic-core memories then in use.

Later that year, some people from Busicom, a young and enterprising Japanese calculator manufacturer, came to Intel looking for a custom-chip manufacturer. They wanted a set of approximately 10 custom circuits for the heart of a new low-cost, desktop-printing calculator.

Intel was in no position to bid for this totally custom contract. The company had no in-house expertise in random-logic design, and it would have taken too many engineers to do the work. But Ted Hoff, manager of the Application Research Department at Intel, thought there was a better way to handle this task.

In those days, there was a controversy about calculator design: standard versus custom. The proponents of custom design were in the majority. They argued that designing general-purpose calculator chips wasn't cost-effective: Standard chips would need to incorporate too many options and thus would be bigger and more expensive than custom-tailored ones.

Standard-design proponents argued that if you structured



ILLUSTRATION: ROBERT FORSBACH © 1992

the calculator as a small programmable computer, it could be both versatile and cost-effective. Fairchild had already done pioneering work in this area, developing a 1-bit serial CPU architecture, as had Rockwell, where Michael Ebertin and his coworkers designed a more sophisticated CPU. The idea of a "CPU on a chip" had been around since the mid-1960s.

Since the invention of the IC in 1959, the semiconductor industry had doubled the number of components integrated into a single chip every year. In the early 1960s, small-scale integration (SSI) allowed a few tens of components to form simple logic gates. By the mid-1960s, medium-scale integration (MSI) enabled a few hundred components to function as counters, adders, multiplexers, and so on. Large-scale integration (LSI), capable of integrating a few thousand components on a single chip, would soon occur.

A few SSI devices had replaced printed circuit boards containing discrete components (e.g., transistors, diodes, and resistors). A few MSI devices had replaced printed circuit boards containing many tens of SSI devices. It was obvious that a few LSI devices could soon replace printed circuit boards containing many tens of MSI devices.

Engineers wondered what kind of a general-purpose function could possibly need that many components. The answer was already evident: semiconductor memories and CPUs for small computers. Such CPUs already needed one or more printed circuit boards that were full of SSI and MSI components. In the late 1960s, LSI arrived, and it was just a matter of time until a CPU on a chip appeared. Hoff saw in the Busicom need an opportunity to define a small set of standard components designed around this CPU-on-a-chip idea.

During the fall of 1969, Hoff, aided by Stan Mazor, an applications engineer at Intel, defined an architecture consisting of a 4-bit CPU, a ROM to store the program instructions, a RAM to store data, and several I/O ports to interface with external devices such as the keyboard, printer, switches, and lights. They also defined and verified the CPU instruction set with the help of Busicom engineers—in particular, Masatoshi Shima.

BYTE ACTION SUMMARY

While the microprocessor has made the personal computing revolution possible, the first single-chip CPUs were not greeted with enthusiasm. Engineers who designed the early microprocessors fought technical battles and management indifference. In hindsight, inventions that change the world seem to have a certain inevitability about them. But the real contribution—and risk—lie *not in* conceiving them but in making them work.

Enduring the Pains of Birth

While working at Fairchild in 1968, I developed silicon-gate technology, a new process technology for fabricating high-density, high-performance MOS ICs. Intel adopted this technology, allowing it to build high-performance memories and the microprocessor before the competition did. My desire to design complex ICs with silicon-gate techology led me to work for Intel.

So, in April 1970, my new job at Intel was to design a calculator chip set. Presumably, Hoff and Mazor had already completed the architecture and logic design of the chip set, and only some circuit design and chip layouts were left to do. However, that's not what I found when I started at Intel, nor is it what Shima found when he arrived from Japan.

Shima expected to review the logic design, confirming that Busicom could indeed produce its calculator, and then return to Japan. He was furious when he found out that no work had been done since his visit approximately six months earlier. He kept on saying in his broken English, "I came here to check. There is nothing to check. This is just idea." The schedule that was agreed on for his calculator had already been irreparably compromised.

Shima and I were in the same boat. Hoff was away on business and thought his job was finished. Mazor could not resolve the remaining architectural issues that Shima promptly brought up. There I was—behind before I had even begun. I worked furiously, 12 to 16 hours a day.

First, I resolved the remaining architectural issues, and then I laid down the foundation of the design style that I would use for the chip set. Finally, I started the logic and circuit design and then the layout of the four chips. I had to develop a new methodology for random-logic design with silicon-gate technology; it had never been done before.

To make the circuits small, I had to use bootstrap loads, which no one at Intel thought was possible with silicon-gate technology. When I demonstrated them, bootstrap loads were promptly put to work in the ongoing memory designs as well.

I called the chip set "the 4000 family." It consisted of four 16-pin devices: The 4001 was a 2-Kb ROM with a 4-bit mask-programmable I/O port; the 4002 was a 320-bit RAM with a 4-bit output port; the 4003 was a 10-bit serial-in, parallel-out shift register to be used as an I/O expander; and the 4004 was a 4-bit CPU.

The 4001 was the first chip designed and laid out. The first fabrication of the 4001 (called a *run*) came out in October 1970, and the circuit worked perfectly. In November, the 4002 came out with only one minor error, and the 4003, also completed, worked perfectly. Finally, the 4004 arrived a few days before the end of 1970. It was a major disappointment because one of the masking layers had been omitted in the wafer processing. The run was unusable.

Three weeks after that disappointment, a new run came. My hands were trembling as I loaded the 2-inch wafer into the probe station. It was late at night, and I was alone in the lab. I was praying for it to work well enough that I could find all the bugs so the next run could yield shippable devices. My excitement grew as I found various areas of the circuit working. By 3:00 a.m., I went home in a strange state of exhaustion and excitement.

Verification continued for a few more days. When the testing was finished, only a few minor errors had been found. I was elated. All that work had suddenly paid off in a moment of intense satisfaction.

In February 1971, the 4004 masks were corrected, and a new run was started. At about the same time, I received the ROM codes from Busicom so that I could tool the masks and make the production 4001s for the first calculator.

By mid-March 1971, I shipped full kits of components to Busicom, where Shima verified that his calculator worked properly. Each kit consisted of a 4004, two 4002s, four 4001s, and two 4003s. It took a little less than one year to go from the idea to a fully working product.

Now that the first microprocessor was a reality, I thought that the chip could be used for many other applications. Unfortunately, Intel's management disagreed, thinking that the 4000 family was good only for calculators. Furthermore, the 4000

family had been designed under an exclusive contract. It could not be announced or sold to anyone but Busicom.

The opportunity to prove that the 4000 family was good for other applications came when the need for a production tester arose. The tester was clearly not a calculator application, so I decided to use the 4004 as the tester's main controller. In that project, I gained considerable insight into what could and could not be done with the 4000 family. When the tester was successfully completed, I had additional ammunition to convincingly lobby for the 4000 family's introduction.

I urged Robert Noyce, then president of Intel, to market the 4004. I suggested that perhaps Intel could trade some price concessions for nonexclusivity. (I had heard from Shima that Busicom was hurting in the marketplace and needed a lower price to effectively compete.) Noyce succeeded in obtaining nonexclusivity from Busicom for the 4004 for applications other than calculators. Shortly after that, in mid-1971, Intel decided to market the 4000 family.

In November 1971, the 4000 family, now known as MCS-4 (for Microcomputer System 4-bit), was officially introduced with an advertisement in major trade publications. The main caption read, "Announcing a new era of integrated electronics"—a very prophetic ad.

A Younger but Brighter Sibling

In 1969, Computer Terminal Corp. (now Datapoint) visited Intel. Vic Poor, vice president of R&D at CTC, wanted to integrate the CPU (about 100 TTL components) of CTC's new intelligent terminal, the Datapoint 2200, into a few chips and reduce the cost and size of the electronics.

Hoff looked at the architecture, the instruction set, and the CTC logic design and estimated that Intel could integrate it all on a single chip, so Intel and CTC entered into a contract to develop the chip. The Datapoint CPU chip, internally called the 1201, was an 8-bit device. Intended for intelligent terminal applications, it was more complex than the 4004.

The 1201 looked like it would be the first microprocessor to come out, since its design was started first, and I had four chips to design, the CPU being the last. I was a bit disappointed, but I had enough to worry about. However, after a few months of work on the 1201, the designer, Hal Feeney, was asked to design a memory chip, and the CTC project was put on ice.

In the meantime, CTC had also commissioned Texas Instruments to do the same chip design as an alternative source. At the end of 1970, Intel resumed the 1201 project under my direction, and Feeney was reassigned to it.

Early in June 1971, TI ran an advertisement in *Electronics* describing its MOS LSI capabilities. A picture of a complex IC with the caption "CPU on a chip" accompanied a description of TI's custom circuit for the Datapoint 2200. The ad continued, "TI developed and is producing it for Computer Terminal Corp. . . . " and gave the chip's vital statistics. The dimensions were 215 mils by 225 mils, a huge chip even for 1971 technology and 225 percent larger than Intel's estimate for the 1201.

The TI chip, however, never worked and was never marketed. It faded away, not to be heard from again until TI's current legal battles. Surprisingly, TI patented the architecture of the 1201, which was Datapoint's architecture with Intel's inputs, and now asserts broad rights on the microprocessor. TI might have been the first company to announce the microprocessor, but making it work was the trick.

An invention requires a reduction to practice, not just an idea. And in 1990, the U.S. Patent Office awarded a patent to Gilbert Hyatt for the invention of the microcomputer chip (about 20 years after his original filing date). News of the award took the industry by surprise because Patent Office proceedings are secret and Hyatt wasn't widely known. While Hyatt was said to have built a breadboard prototype implementation (using conventional components) of his microprocessor architecture, no single-chip implementation was ever produced. Again, this idea was not reduced to practice. For more information on this, see "Micro, Micro: Who Made the Micro?," January 1991 BYTE.

What Gilbert Hyatt, TI, and others failed to do, Intel did: It made the first microprocessor work—at a low cost and in volume production. It took vision, guts, and lots of work to bring to market a product that was different from all the others, a product that required lots of customer training, support, and groundwork. Intel did it, taking a big risk at a time when it was still small and could ill afford to fail.

Three critical tasks had to be performed before the idea of the microprocessor could take root. First, the production technology of the time had to economically implement a useful architecture. Second, someone had to design, develop, and bring the chip to production with sufficiently low manufacturing costs. And third, the microprocessor had to be made available to the general market. This last task required a true belief in the device and its ability to transform hardware design.

During the summer of 1971, as work on the 1201 was progressing nicely, Datapoint decided that it didn't want the 1201 anymore. The economic recession of 1970 had brought the price of TTL down to where the 1201 was no longer attractive. However, because Seiko of Japan had expressed an interest in it, Intel decided to continue with the project. Datapoint agreed to let Intel use its architecture in exchange for canceling the development charges. Intel was free to commercialize the 1201 as a proprietary product.

Designed after the 4004, the 1201 was not too difficult a project. Architecturally, the 1201 was very similar to the 4004—despite the 1201's being an 8-bit CPU—and many of the design solutions used in the 4004 readily applied to the 1201. There was only one bad moment.

Intel was all set to introduce the 1201 (later renamed the 8008) when I discovered some intermittent failures. It took me a feverish week to solve the problem. It was a nasty one, at the crossroads of device physics, circuit design, and layout: The charge stored in the gate of the transistors in the register file was leaking away due to substrate injection. I had to modify the circuit and the layout to fix the problem.

Making the Sale

To use a microprocessor, you first had to visualize a problem as a computer program and then write and debug it in some kind of hardware-simulation environment before committing the program to ROM. Fortunately, Intel had just developed the 1701, the first EPROM to use a floating polysilicon gate as the storage element.

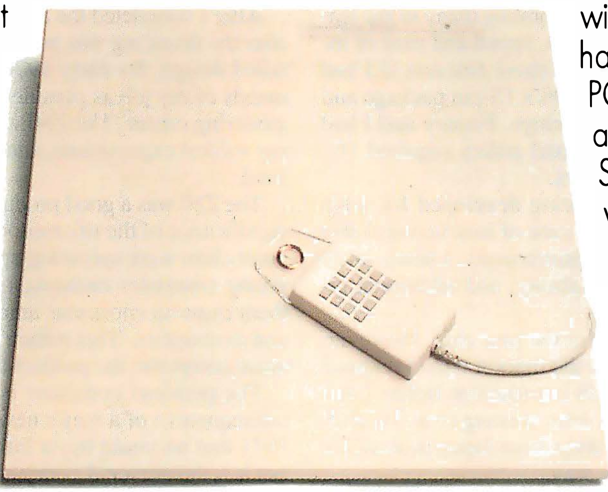
The 1701 was a 2-Kb device programmable with special hardware and erasable with ultraviolet light. Introduced six months earlier than the 1201, the 1701 was a solution looking for a problem. However, it made possible the development of a board that you could use to develop, run, and debug software for the MCS-4.

Microprocessors required much more marketing effort than conventional components. A typical component would have a 6- to 10-page data sheet, and that was all. The MCS-4 had the data sheets, a programming manual, applications notes showing how to use the components, a development board capable of implementing a functional prototype of the hardware, and a cross assembler (i.e., a program running on a minicomputer that allowed the conversion from instruction mnemonics into machine language).

continued

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All this paraphernalia required a lot more knowledge, complexity, and cost than the semiconductor industry was prepared to handle. In addition, the engineers had to fundamentally change their approach to hardware design. With the microprocessor, you had to visualize problems in terms of software. This was the hardest obstacle of all.

In April 1972, Intel introduced the 8008, with a group of supporting chips, as a family of products called the MCS-8. The supporting chips were standard Intel products with the names changed. MCS-8 looked impressive, and market interest was high, but sales were slow.

Customers needed more than the simple design aids that Intel offered; they needed far more hardware and software tools, training, and applications support than had been anticipated. So Intel provided them with a variety of software and hardware design aids and fostered a massive engineer training program carried out by external consultants.

Then the idea of a development system arose, and Intel's management decided to commit the company in that direction. The development system is a self-contained computer specialized for developing and debugging microprocessor software. A year after the microprocessor introduction, Intel was receiving more revenues from development systems than from microprocessor chips.

The Real Hotshot

Late in the summer of 1971, I went to Europe to give a series of technical seminars on the MCS-4 and the 8008 and to visit customers. It was an important experience. I received a fair amount of criticism—some of it valid—about the architecture and performance of the microprocessors. The more computer-oriented the company I visited was, the nastier people's comments were.

When I returned home, I had an idea of how to make a better 8-bit microprocessor than the 8008, incorporating many of the features that people wanted: most important, speed and ease of interfacing. I could have boosted both of these features if I had used a 40-pin package instead of the 8008's 18-pin package and integrated the functions of the support chips. Feeney and I had wanted to do that with the 1201, but Intel policy required 16-, 18-, and, on exception, 24-pin packages.

Using the new *n*-channel process being developed for 4-Kb DRAM would also improve speed and ease of interfacing. I also wanted to make several functional improvements: a better interrupt structure, more memory addressability, and additional instructions.

By early 1972, I started lobbying for the new chip. However, Intel management wanted to see how the market would respond to the MCS-4 and, later, to the MCS-8 introduction before committing more resources. I thought we were wasting time. I had already asked Shima to come to California from Japan to work for me, and visa formalities were under way.

In the summer of 1972, the decision came to go ahead with the new project. I finished the architecture and design feasibility so that my coworkers and I could go full steam when Shima arrived in November.

The first run of the new microprocessor, the 8080, came in December 1973. My coworkers and I corrected a few minor errors, and Intel introduced the product in March 1974. After that, Intel was clearly the leading microprocessor supplier, although other companies had competing products.

In 1972, Rockwell announced the PPS-4 (similar to the MCS-4 but packaged in 42-pin packages). The PPS-4 used four-phase design techniques and metal-gate MOS technology and achieved about the same speed as the MCS-4, thanks to a more parallel operation. Rockwell engineers stemmed the limitations of metal-gate MOS technology for a while, but the PPS-8, introduced after the 8080, was no match for it.

The only serious competition for Intel came from Motorola. Motorola's product, the 6800, used MOS silicon-gate technology and was introduced about six months after Intel's 8080. In many ways, the 6800 was a better product. However, the combination of timing, more aggressive marketing, availability of better software and hardware tools, and product manufacturability—the 8080 chip size was much smaller than the 6800's—gave Intel the lead.

The 8080 really created the microprocessor market. The 4004 and 8008 suggested it, but the 8080 made it real. For the first time, several applications that were not possible with prior microprocessors became practical. The 8080 was immediately used in hundreds of different products. The microprocessor had come of age.

A New Challenge

By the summer of 1974, I had grown restless. From the beginning, I had led all the microprocessor development activity at Intel, and, with time, I was responsible for all the MOS chip-design activity, except that on DRAMs. Intel had grown into a large company, and I found the environment stifling. So, with Ralph Ungermann, one of my managers, I decided to start a company that, unlike Intel, would be totally dedicated to the microprocessor market.

In November 1974, Zilog was founded, and a little more than a year later, the Z80 CPU, the first member of the Z80 family, was born. I had the idea for the Z80 in December 1974. It had to be a family of components designed to work seamlessly together and able to grow. It had to be totally compatible with the 8080 at the machine-instruction level and yet incorporate many more features, registers, and instructions.

After I completed the architecture and the design feasibility and after the financing was arranged, Shima joined Zilog to do the detailed design. By early 1976, the Z80 was a reality, and the demands of my job as president of Zilog had put an end to my engineering career. The Z80 was extremely successful, surpassing my wildest expectations, and Zilog became a major competitor of Intel.

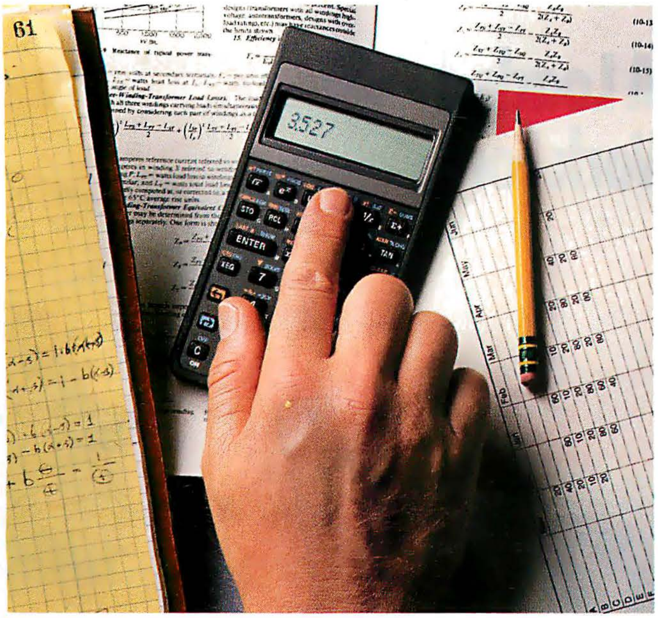
The Z80 was a good product, but its timing was also lucky. The significance of the microprocessor was becoming evident. Computer clubs were sprouting up throughout the U.S. The number of young computer enthusiasts was increasing rapidly, and with them came an enormous amount of creative energy, enthusiasm, and exuberance. That milieu was the breeding ground of the personal computer, the product that popularized the microprocessor.

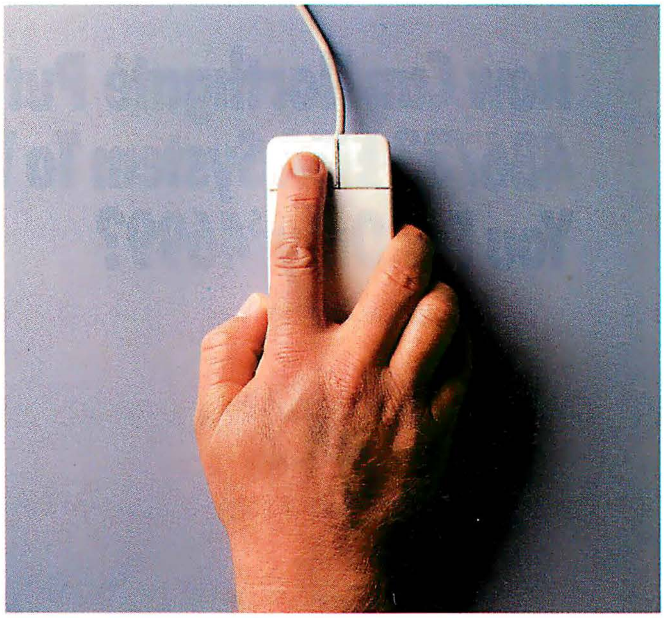
The personal computer is one example of the unpredictable consequences of a major new technology. Of course, we knew in 1971 that we could buy a little computer that would fit on a desk, but it is the personal computer as a socioeconomic phenomenon rather than as a feat of engineering that was a surprise to me.

By 1977, microprocessors were firmly planted in the world and were becoming part of the fabric of everyday technology. From that point on, it became a matter of building faster, bigger, better, less expensive microprocessors. And the industry has done just that. Fueling this process is the continuing improvement in semiconductor processing technology, the source of the microelectronics revolution. ■

Federico Faggin conceived, designed, and codesigned many of the earliest microprocessors, including the Intel 4004, 8008, 4040, and 8080, as well as the Zilog Z80. He is cofounder and president of Synaptics (San Jose, CA), a company that is dedicated to the creation of hardware for neural networks and other machine-learning applications. You can reach him on BIX c/o "editors."

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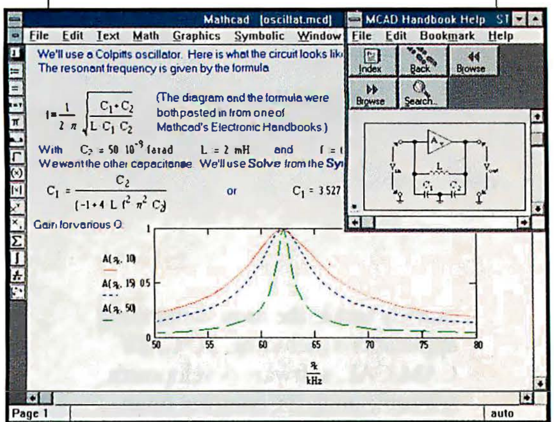


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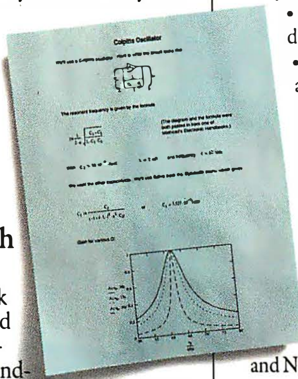


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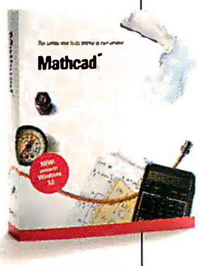
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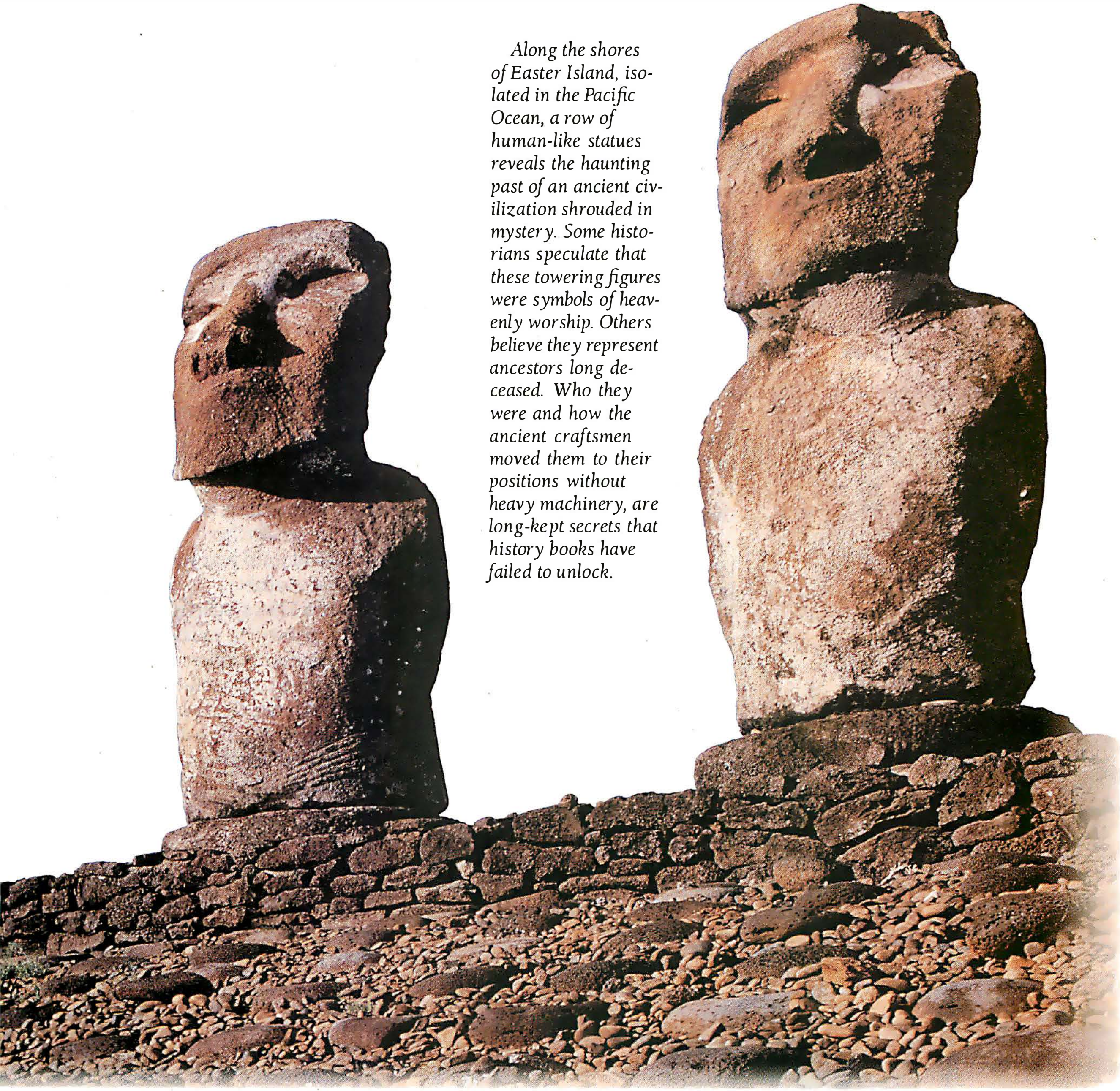
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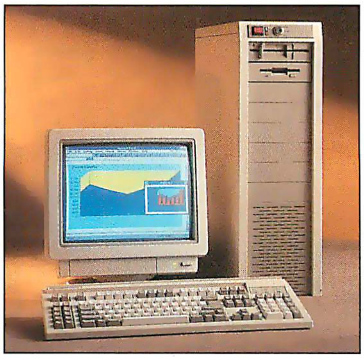
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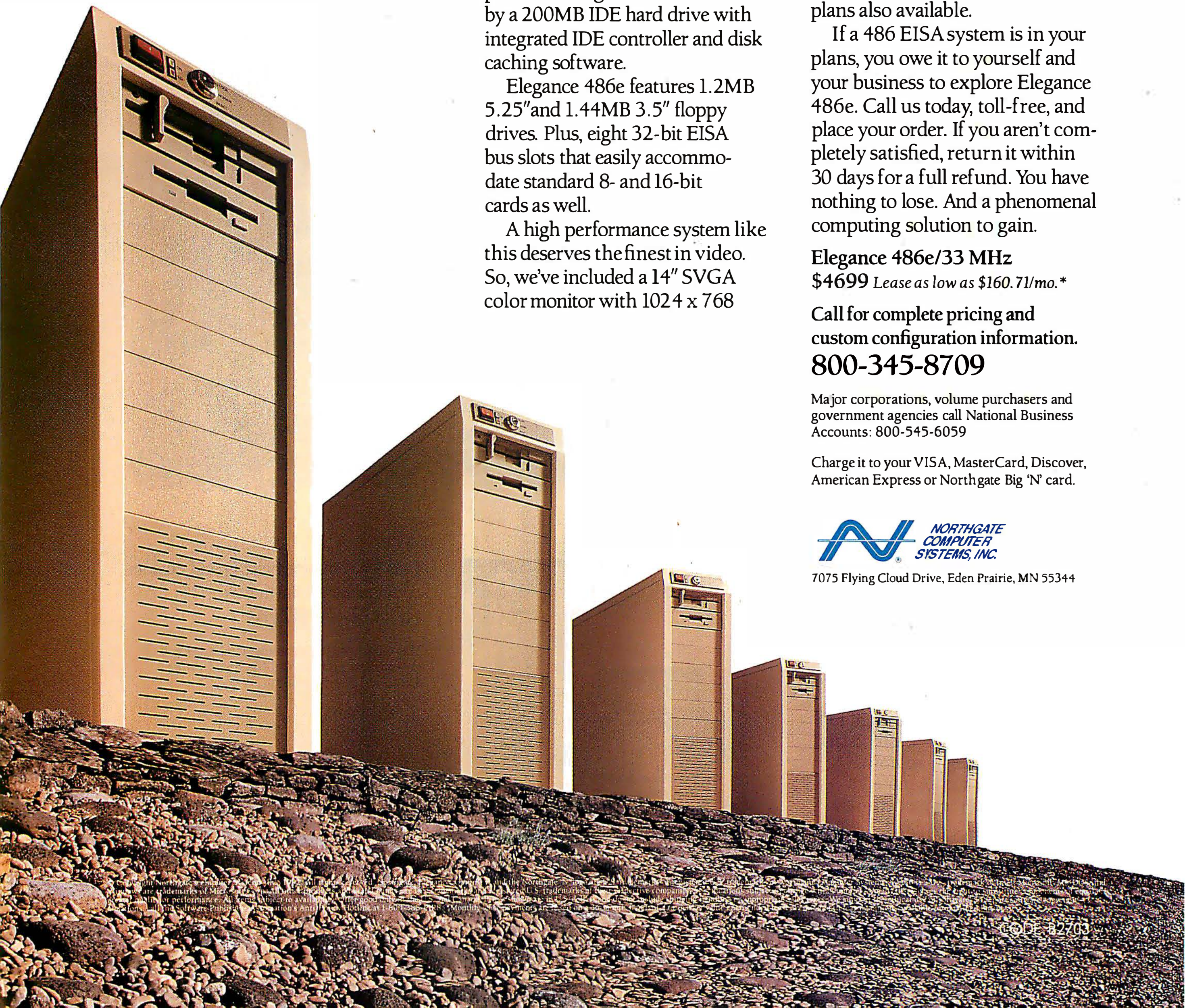
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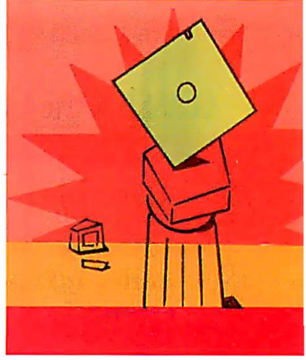
The system comes complete with eight 32-bit EISA bus slots (six bus master and two slave) that give Elegance 486e the ability to manage large Local Area Networks at near processor speed.






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FEATURE



CLASSIC LANGUAGES, PART 6

BASIC

Still the most popular language on microcomputers, BASIC has made considerable changes over the years

DORIS APPLEBY

This six-part series, which has considered languages that have stood the test of time, would not be complete without presenting BASIC (for Beginner's All-purpose Symbolic Instruction Code). However, as BYTE readers have been kept up to date on changes over the years, the discussion will be brief. I want to reserve some space for taking a stab at a question posed by Russell Brown, a mathematician now retired from the U.S. Naval Research Lab, who asked, "But why so many different languages?"

BASIC Beginnings

BASIC, which is undoubtedly the most popular computer language, is bundled with virtually every microcomputer sold. It was developed in 1964 by two Dartmouth professors, John Kemeny and Thomas Kurtz. They noticed that most decision makers in business and government are nonscientists and that their decisions dramatically affect the worlds of work and public affairs. They wondered how sensible decisions about computing and its use could be made by people essentially ignorant of the subject. They agreed that you can no more learn computing by listening only to lectures and having no computer than you can learn to drive a car by using only a manual and having no car.

Two problems needed to be overcome. First was the inaccessibility of computers, which ran in batch mode from punch cards; second was the need for a language that was easier to learn than the highly mathematical FORTRAN. BASIC, with its accompanying time-share system, solved both problems. It operated then, as now, as a desktop calculator, where you could enter

```
PRINT LOG(25)
```

and get an immediate answer, or as a programming language, with which you could write and save complete programs. Early BASIC was interpreted; now, newer versions can be compiled as well.

BASIC's detractors were powerful and vociferous, with perhaps the most damaging charge coming in 1975 from Edsger Dijkstra: "It is practically impossible to teach good programming to students that have had a prior exposure to BASIC: As potential programmers, they are mentally mutilated beyond the hope of regeneration." It was the much-maligned GOTO as the principal control structure that led to such strong condemnation. And I must agree that such was my experience during the late 1970s. Converting a gung-ho high school BASIC hacker to structured programming when GOTOs work just fine is hard indeed.

Dartmouth BASIC was never copyrighted or standardized, so different versions that took advantage of various microcomputer features became available from almost every software developer. These included BASEX, Integer BASIC, MITS BASIC, Tiny BASIC, SWTP BASIC, RM BASIC, BAZIC, BASIC-09, Better BASIC, Professional BASIC, Macintosh BASIC, Microsoft BASIC, Applesoft BASIC, CBASIC, SBASIC, BASICA, GWBASIC, TBASIC, and a standardized ANSI Minimal BASIC in 1978 (so minimal that it was almost totally ignored by the industry).

What's New?

Kemeny and Kurtz found this proliferation appalling and dubbed these horrible dialects of such a beautiful language "Street BASIC." They thus formed a corporation in the early 1980s and developed True BASIC, a version that meets the ANSI and ISO standard. A True BASIC program will run on any machine that supports an ANSI BASIC system. Its

BYTE ACTION SUMMARY

Even though BASIC has humble roots and a reputation for supporting poor programming practices, it has evolved more than any other classic language. The plethora of versions have coalesced into a few real standards.

Listing 1: *True BASIC's syntax for writing program modules.*

```
MODULE name
 PUBLIC var 1, ..., array1(size), ... !global variables
 PRIVATE routine1, ...                !local variables
 SHARE var1, ...                      !shared in
                                      !procedures
                                      !within
   ...                                !the module
 statements                           !initialization
                                      !code
   ...
 procedures
   ...
END MODULE
```

Listing 2: *True BASIC code that sorts a list of student names in descending order according to their grade-point average (from* True BASIC by Problem Solving *by Brian D. Hahn [Weinheim, Germany: VCH, 1988, p. 109]).*

```
DIM List(100)                !order of merit list
DIM Mark(100)                !marks
DIM Names$(100)              !names in original order

LET N = 0                    !counter
DO WHILE MORE DATA
  LET N = N + 1
  READ Name$(N), Mark(N)
  LET List(N) = N            !initialize the list
LOOP

LET K = 0

DO                           !outer loop of bubble
!sort
  LET Swaps = 0              !number of exchanges
                             !per pass
  LET K = K + 1              !count the passes
  FOR J = 1 TO N - K         !count the tests
      IF Mark(List(J)) < Mark(List(J+1)) THEN
         LET Temp = List(J)
         LET List(J) = List(J + 1)
         LET List(J + 1) = Temp
         LET Swaps = Swaps + 1
      END IF
  NEXT J
LOOP UNTIL Swaps = 0         !must be sorted then

FOR K = 1 to N
  PRINT USING "<#########":Name$(List(K))
  PRINT USING " ###": Mark(List(K))
NEXT K

DATA Alice, 54
DATA Brian, 30
DATA Charles, 100
DATA Debby, 47
DATA Ethel, 78
END
```

compiler has two windows: an editing window, where you can write and edit programs, and a history (or command) window, where you can run programs and interact with them.

Programming language concepts have developed since the 1970s, along with new languages that implement the new concepts as well as take advantage of improvements in hardware. BASIC has changed also, and the two leading implementations are True BASIC and QuickBasic from Microsoft.

When BASIC was first developed, notions of structured programming were mostly in the paper-and-pencil stage. Structured code reflects in appearance a program's organization. Notions of structure include blocks, where data can be localized, and data structures, such as arrays, records, and lists, to name only a few. The new BASICs include structured features such as IF...THEN...ELSEIF...ELSE...END IF, FOR...NEXT, DO...WHILE...LOOP, DO...LOOP UNTIL, and various CASE statements. They also support graphics, matrix-handling functions, and internal and external functions and procedures. Line numbers are optional, and you can insert or delete them using the menu bar.

Another concept implemented in modern high-level languages is modularization, where data and related procedures can be bundled together, with some features kept hidden from a user. True BASIC has added this feature in the form shown in listing 1. QuickBasic's version calls global variables COMMON, local variables STATIC, and shared variables SHARED.

You can save modules and collections of BASIC code in files and include them in other programs with the INCLUDE statement, or you can store procedures and functions in a library, from which you can bring them into a program with the CALL statement. You can save and distribute compiled code in .EXE files, so developers can sell their software without source code.

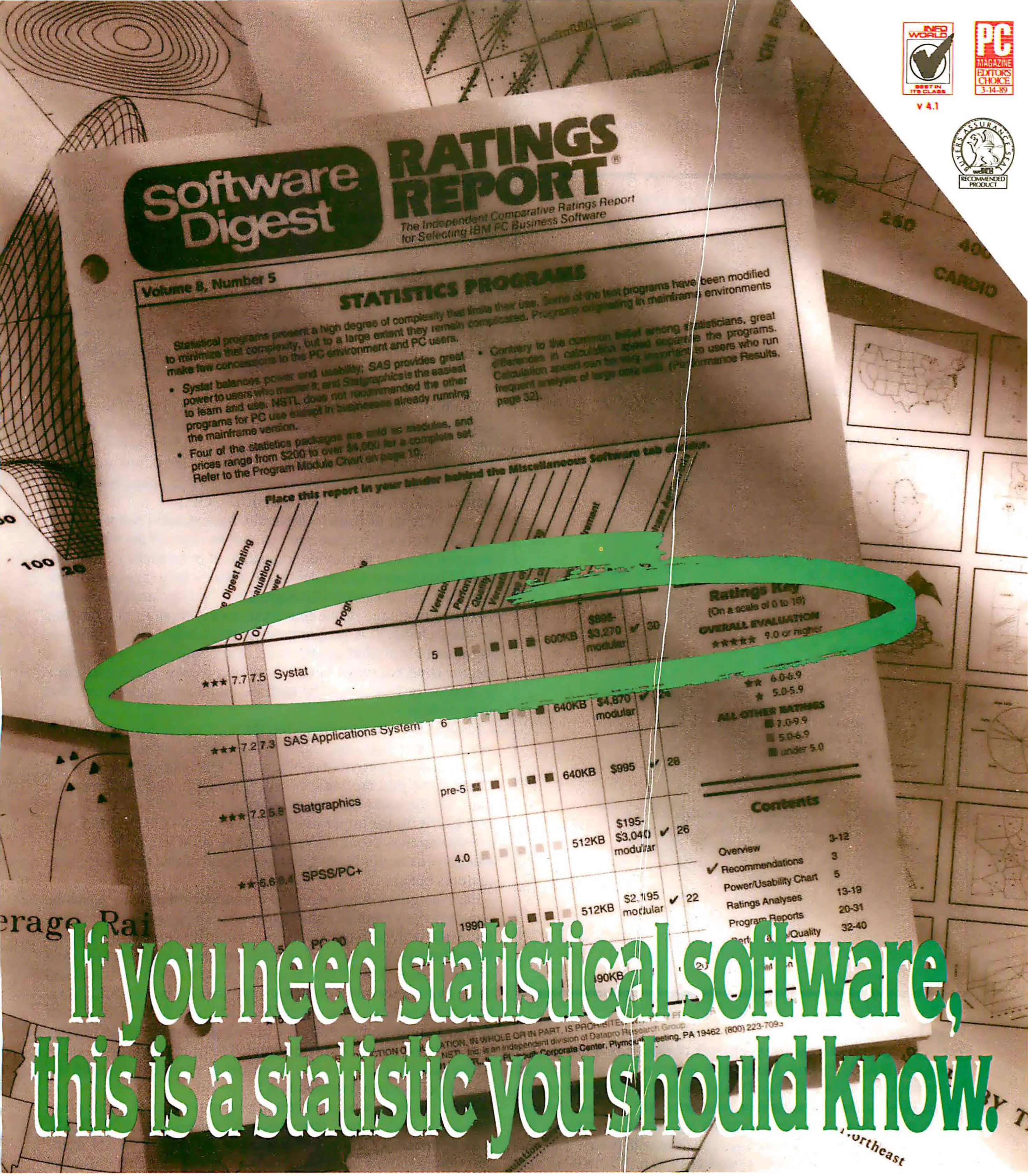
But True BASIC has been kept lean in keeping with its designers' philosophy of simplicity. This is not so with Microsoft's candidates, QuickBasic and Visual Basic for Windows. Microsoft's president, Bill Gates, wants QuickBasic to replace Pascal as the language of choice for high schools. Thus it includes user-defined data types in the form of records. It makes no attempt to adhere to the ANSI/ISO standard but takes full advantage of the DOS environment. Visual Basic, an attempt to make Windows programming easy, includes icons that can be designed into the user interface as well as used while writing BASIC code.

As an example of the different capabilities of True BASIC and QuickBasic, the programs in listing 2 (True BASIC) and listing 3 (QuickBasic) sort a list of student names in descending order according to their grade-point average. There are several things to notice in these two versions for sorting an array of "pointers" to fixed array elements. First is that neither version has true pointers that contain memory addresses. An array, called `List` or `Rank`, keeps track of the array location instead. Second is the existence of record types in QuickBasic. Third is the built-in Swap function in QuickBasic, which has to be programmed in True BASIC.

You may wonder why I changed the name of the True BASIC `List` array to `Rank` in the QuickBasic version. Well, it turns out that `List` is a keyword in QuickBasic that lets you reassign function keys in the DOS system. Lots of things like that show up. But if you're wedded to DOS, you'll learn all these keywords quickly enough.

There are advantages to strong typing and variable declarations, as in Pascal and Ada. It is very hard for inexperienced programmers to detect errors in BASIC. Maybe BASIC is for experienced programmers like Art Ramirez (whom I will discuss in a moment) or those who want little more than a fancy calculator, and the strongly typed languages are better for beginning programmers.

continued



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Listing 3: *The QuickBasic equivalent of the program in listing 2.*

```
DATA 5
DATA Alice, 54
DATA Brian, 30
DATA Charles, 100
DATA Debby, 47
DATA Ethel, 78:
TYPE Student                              !user-defined
                                          !record type
   FirstName AS STRING * 9
   Mark AS INTEGER
END TYPE
   READ Size%
'  $DYNAMIC                               !arrays to follow
                                          !are dynamic
   DIM Class(1 TO Size%) AS Student      !typed array
   DIM Rank(1 TO Size%) AS INTEGER
   I% = 0
   DO UNTIL I% = Size%
     I% = I% + 1
     READ Class(I%).FirstName
     READ Class(I%).Mark
     Rank(I%) = I%                          !initialize Rank
   LOOP
   LET K% = 0
   LET Swaps% = 1
   DO UNTIL Swaps% = 0
     LET Swaps% = 0
     LET K% = K% + 1
     FOR J% = 1 TO Size% - K%
       IF Class(Rank(J%)).Mark < Class(Rank(J% + 1))
            Mark THEN
         SWAP Rank(J%), Rank(J% + 1)
         LET Swaps% = Swaps% + 1
       END IF
     NEXT J%
   LOOP
   FOR K% = 1 TO Size%
     PRINT Class(Rank(K%)).FirstName;
            Class(Rank(K%)).Mark
   NEXT K%
END
```

Who Uses It?

You can customize operating-system commands with macros written in BASIC. Many laboratory instruments also have an understanding of BASIC. Art Ramirez, a low-temperature physicist at AT&T's Bell Laboratories, measures magnetic and thermal effects occurring during experiments on superconductivity. He writes controllers for various devices such as voltmeters, using either GWBASIC (QuickBasic's predecessor) or TBASIC (a version of True BASIC from a company called TransEra). His instruments "understand" BASIC, he finds it quick and easy to use, and he feels no need for anything fancier. The True BASIC company sponsors a group that distributes shareware among engineers and others who might be interested in scientific applications.

Thousands of commercial programs have been written in BASIC by people with good ideas but little programming experience. What do you do when a program needs upgrading but is written in a version of BASIC that's no longer supported by its distributor? Ah, there's the rub—in any nonstandardized language, not just BASIC. The hodgepodge of BASICs appears to have settled down to two major contenders: the standardized, simple True BASIC and QuickBasic, which has many more features. Either one has enough structures to program some pretty serious applications.

Why So Many Different Languages?

In this series, I have looked at six language survivors from the 1960s. There are other, newer languages as well: C, Ada, Prolog, and ML, to name the most popular ones. To address the question of why so many languages, I suggest looking at a book by Thomas Kuhn called *The Nature of Scientific Revolutions* (University of Chicago Press, 1962).

The book was controversial because Kuhn claimed that a scientific notion was valued as much because of the group of people who found it useful as because of any intrinsic merit it might have. He traced new paradigms from the breakdown of older ones. Among programming languages, BASIC arose because of the breakdown of FORTRAN and ALGOL.

Peter Wegner of Brown University has extended Kuhn's notion of paradigms to programming languages. Part of his motivation in doing this was to provide some kind of order in the general babel of languages and dialects. He divides language paradigms into two broad categories: imperative and declarative. An *imperative* language is one that facilitates computation by means of state changes. A programmer is responsible for making assignments that change the state of a computer's memory. A *declarative* language is one in which a programmer submits a relation or function to be realized and a computer figures out how to do it.

Each of the two paradigms has three subcategories; among imperative languages are those that are block structured, object based, and supportive of concurrency. Declarative languages include those that are logic based, functional, and database specific. Of the older languages covered in this series, FORTRAN and COBOL are imperative, while Lisp, SNOBOL, and APL are declarative. None serves as a very good example of a subcategory, as newer languages have implemented these particular features better.

Each language has a devoted community that was, possibly, attracted away from an earlier language. These practitioners communicate with each other and collaborate on work using the preferred language of their group. Number-crunching scientists and engineers use FORTRAN, businesses use COBOL, novices and those looking for quick-and-easy programming use BASIC, AI researchers use Lisp, those in the humanities prefer SNOBOL, and systems analysts use APL for building experimental systems. Any of these groups may be attracted to a new language, but, as Kuhn points out, "retooling is an extravagance to be reserved for the occasion that demands it."

There are those who predict that programming will settle down into a few widely used languages—C superseding FORTRAN, Ada replacing COBOL and attracting some FORTRAN users, and Common Lisp becoming the language of choice for all functional programmers. You need only attend one or two computer conferences to find a vociferous group advocating the demise of BASIC. But members of each community appear to be pretty content with what they have, so don't look for consolidation anytime soon. ■

Doris Appleby writes about mathematics, computer science, and pedagogy. She is also the chairperson of mathematics/computer science/information systems at Marymount College in Tarrytown, New York, and the author of Programming Languages—Paradigm and Practice *(McGraw-Hill, 1991). You can reach her on BIX c/o "editors."*

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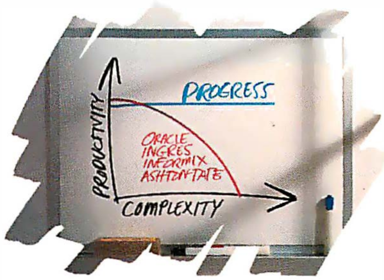




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SCALING THE MEMORY PYRAMID

The balance of different types of memory and storage in a computer system goes a long way toward determining its performance

BOB RYAN

Consider the throughput of a hypothetical RISC-based workstation that can execute one machine instruction per clock cycle. With a 25-MHz clock, it could spit out 25 million 32-bit results every second, with a throughput of 100 MBps.

To keep the CPU of such a system operating at full speed, you need a memory system that can load one instruction and two operands and store one result every clock cycle. That's four 32-bit pieces you would have to move each cycle, which translates into a potential required bandwidth of 400 MBps.

Today, there are no desktop-class machines with memory systems capable of such bandwidths. The stumbling block is not so much technical as it is economic: High-speed memory systems are expensive, and they exhibit a price/performance curve that has more in common with an exponential function than with a linear one. The challenge in designing or purchasing a desktop system is to balance the conflicts between optimal memory design and cost.

This State of the Art section examines computer storage and how it relates to performance. This article provides an overview of today's computer storage systems and how they are likely to evolve in the near future. In "What to Stash in a Cache," Steven J. Vaughan-Nichols takes an in-depth look at the most common method used to expand the major bottleneck in most computer systems: the processor-to-main-memory interface. In "Storage Management," Mike Robinson examines the issues you'll confront in the brave new world of network-based storage and archiving. And in "Embedded Intelligence," authors Rod Kirk, Tim Christianson, and Danial Faizullabhoy explore the growing intelligence found in mass-storage systems.

The Great Pyramid

Computer storage is anything but monolithic. In a typical system, you can easily have four or five different types of storage, from the registers that feed a processor's functional units to the tape drives that back up the hard disk.

Although each type of storage has its own functions and characteristics, each is also bound to the others in a coherent memory system. This system is designed to keep the processor as busy as possible by supplying it with required information (i.e., instructions and data) in a timely manner.

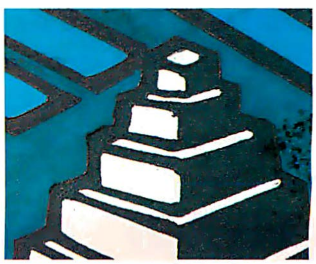
The relationships between the different types of memory can best be viewed as a pyramid. The base of each segment represents its relative size in comparison to the other storage types. Its height represents its relative speed (higher equals faster) and cost (higher equals more expensive). Figure 1 shows the memory pyramid for a typical 486-based desktop computer.

Storage technologies do not advance in lockstep. Memory speeds do not increase at the same rate as processor speeds, and processor speeds, in tum, do not directly relate to the speed of drives. As a result, the relative contribution of each type of storage in an optimal memory system changes almost daily.

Ultimate Storage

The ultimate destination of the contents of any computer storage medium (e.g., memory, hard disk, and tape) is the processor. It executes the instructions, massages the data, and produces the results.

The processor's actions take place in its functional units, which can include an ALU, an FPU, or perhaps a vector-processing unit. However, before



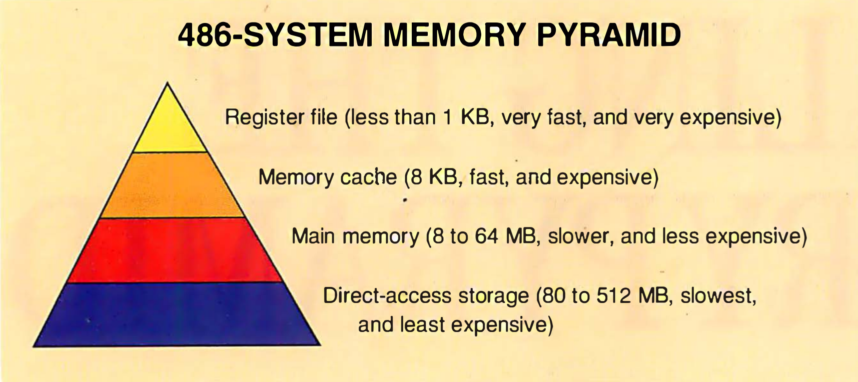


Figure 1: *The memory pyramid for a typical 486-based system consists of four layers. The processor-register file is the smallest (under 1 KB) and the fastest (10-nanosecond access) form of storage on the system. In contrast, the hard disk might store 200 MB (200,000 KB) but require 15 milliseconds (15 million ns) on average to access its contents. On the other hand, the hard disk might cost you less than half a cent per KB, and you can't get the processor registers for less than several hundred dollars per KB.*

an instruction can invoke such a unit and before the unit can massage the data, the processor must retrieve the instruction or data from memory and store it in the registers. Processor registers provide the capstone of the memory pyramid.

Although instructions and data share the same memory, they often take different paths to a register. Some processors use a full Harvard architecture, which features separate paths from memory to the processor for instructions and data. Other designs use a common pathway to the processor but send the instructions and data to different internal caches.

The 486, on the other hand, stores both instructions and data in the same on-chip cache. Only when the processor moves the instructions to the instruction register and the data to the general-purpose registers do instructions and data finally go their separate ways.

Registers are the final storage place for instructions and data before execution. A processor's register file is also the smallest (and thus most expensive) storage facility in a system.

The purpose of the memory pyramid is to get the proper instructions and data into the registers in a timely fashion. The main reason for the success of RISC-based computers over the past few years lies in their ability to keep the proper registers primed with data and instructions. RISC processors feature large register files and specialized fetch-and-store instructions that help to keep the registers filled with the proper data. The future will bring larger register files and greater use of RISC.

BYTE ACTION SUMMARY

Computer storage is anything but monolithic. A typical system can have four or five types of storage. The goal is to get the proper instructions and data into the registers in a timely fashion and to keep the processor busy. Some exciting ways of meeting that challenge are emerging.

Caching In on Main Memory

Below the processor registers on the memory pyramid lies the main memory system. On today's desktop computers and workstations, this system normally consists of the main memory store and one or two caches. One cache is usually located on the processor chip (the *primary cache*), and the other is off-chip (the *secondary cache*).

The processor-to-main-memory interface has always been the main performance choke point in stored-program-type computers. It's a choke point that is becoming progressively narrower.

As figure 2 shows, speed advances in the DRAM chips that make up main memory in personal computers and workstations have not kept pace with advances in processor clock speed. Thus, main memory is more of a drag on processor performance today than it was in the earliest personal computers. As a result of this ever-widening gap, systems designers have turned to smaller, faster, and more expensive cache-memory techniques to keep the processor pipeline as full as possible.

The logic behind caches rests on the principle of locality. As explained by Hennessy and Patterson in *Computer Architecture: A Quantitative Approach* (Morgan Kaufmann Publishers, 1990), this hypothesis has two dimensions, a temporal one and a spatial one.

The principle of locality holds that a program (and thus a processor) tends to access memory items it has accessed recently—the temporal dimension. In addition, a program tends to access memory items located near the items it has accessed recently—the spatial dimension.

A cache, then, is a system that moves recently accessed items and the items near them to a storage medium (typically static RAM or processor RAM) that is faster than main memory's DRAM. Caches are classified by their speed, complexity, and size. Normally, the more complex the logic of the cache controller is, the smaller the cache you need.

Another way that you can differentiate caches is by how they update main memory. A *write-through cache* writes to main memory whenever a cached location is written to; a *write-back cache* writes to main memory only when a particular location is flushed from the cache. The former ensures constant coherency between the cache and main memory; however, its greater use of the memory bus could interfere with other cache-to-main-memory transfers.

Most high-end personal computers use a single cache: High-end 386 machines have off-chip caches, and 486 machines have caches integrated into the processor. In the future, personal computers will follow the lead of workstations and use two levels of caching: a smaller, faster primary cache and a larger, slower secondary cache. In general, caches will become larger and more complex; they must to keep pace with the increasing clock speeds of future desktop machines.

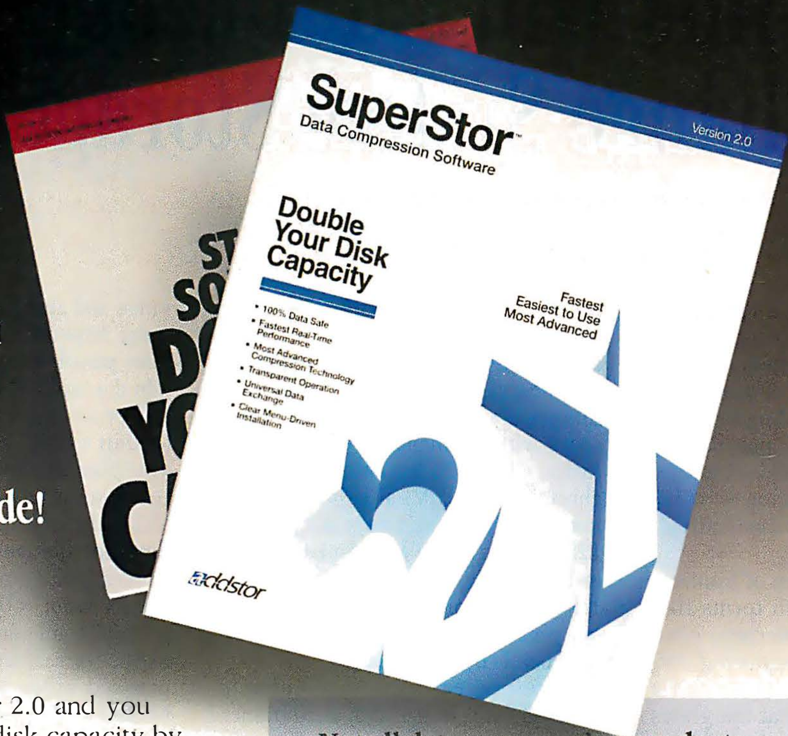
Another recent trend in personal computers is the use of virtual memory. Long a standard feature on Unix workstations, virtual memory lets you use part of your hard disk as main memory. Thus, you don't need to have enough main memory to hold all your executing applications and data at the same time.

Virtual memory was developed at a time when main memory was more expensive than it is now. Today, however, virtual

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How Will Multimedia Change System Storage?

DAVID SPRAGUE

We are witnessing a revolution in the personal computer industry: the multimedia revolution. Multimedia enhances existing applications by adding rich data types (e.g., color photographs, motion video, and audio). It promises to create a new type of application aimed at group productivity rather than individual productivity.

Today, these new types of applications are described with terms like *workgroup computing*, *enterprise computing*, and *computer-supported collaboration*. Their goal is to provide a real-time environment that integrates multiuser, multisite production with information sharing. This information includes traditional forms of data as well as the video and audio data types found in multimedia.

As these new data types are incorporated into desktop computing, they will have an impact on nearly every component in the system—the CPU, memory, mass storage, expansion bus, network, and display. Of specific interest is multimedia's impact on memory and mass-storage components.

To fully integrate rich data types (particularly video and audio) into desktop computing, it is important to understand their nature and key characteristics. Unlike text and two-dimensional graphics, video and audio are time-continuous in nature: They are presented over a period of time at a specific, predefined rate. Such a constraint predetermines two well-known characteristics of video and audio data: They are large and performance-sensitive.

Digital Video

A typical spatial resolution for a digital motion-video window in a desktop application would be 320 by 240 pixels, or one-quarter of the screen at the standard VGA resolution of 640 by 480 pixels. The image quality of video at 320- by 240-pixel resolution is roughly equivalent to that of VHS video.

In most cases, video and photographic images are encoded in a YUV color space with luminance (Y) at full resolution (i.e., 320 by 240 pixels) and chrominance (U,V) at half resolution horizontally and vertically (i.e., 160 by 120 pixels). With 1 byte for each Y, U, and V sample, this gives an average of 1.5 bytes per pixel; that is, one Y byte per pixel, and one U byte and one V byte per 2- by 2-pixel array.

Therefore, each frame of video is 115,200 bytes in size and, at 30 frames per second, requires 3.5 MB of storage to hold 1 second of video. Because motion video contains a lot of redundancy, it can be compressed without significantly degrading image quality.

Video Compression

You can achieve a compressed size of about 4.5 KB per frame with a compression scheme such as the Moving Pictures Experts Group (MPEG) standard (a draft standard for compressed digital video and audio that is targeted at playback from CD-ROM or other digital storage medium at an approximate data rate of 1.5 Mbps) or Intel's PLV (Presentation-Level Video).

After converting a 320- by 240-pixel image to YUV format, the compression ratio needed to condense the image to 4.5 KB is about 26 to 1. Audio data contains a lot less redundancy and cannot be compressed as much. It achieves a compression ratio of only about 4 to 1.

At these compression ratios, a CD-ROM or hard disk with a 500-MB capacity can store an hour of video and audio. The compressed data rate required for real-time playback at 30 frames per second is 135 KBps. This speed not only allows video and audio playback from disk but also makes video and audio transmission via computer networks and T1 digital phone lines possible (see figure A).

In the mid-1990s, motion-video resolution on desktop computers will start to shift to full-TV resolution (640 by 480 pixels). Because there are four times as many pixels on TV as on VGA, this resolution will require four times the storage needed for both compressed and uncompressed video. That's about 460 KB for each uncompressed frame and a data rate of 0.54 MBps for real-time playback of compressed video and audio. The ISO MPEG-2 standard, now in the early stages of development, is targeted at TV-quality video and near-CD-quality audio at a 0.5- to 1.2-MBps compressed data rate.

The move from TV-quality to HDTV-quality video, with image sizes in the range of 1 million to 2 million pixels and compressed data rates of 2.5 to 5 MBps, will be delayed until the late 1990s because of economics as much as technical factors. With the low cost of NTSC and PAL video equipment and a profusion of source material, these formats will be slow to move to HDTV video for all but the most advanced desktop video applications.

The Impact on Memory

The impact of multimedia on the memory subsystems of desktop machines will occur in the number and size of uncompressed video frames stored and, indirectly, in the increase in frame-buffer depth required to properly display video images. In a scheme such as MPEG, two to three frames of video are stored during the encoding or decoding processes, because the scheme uses interframe coding techniques (e.g., motion compensation).

Most early designs of video-accelerator chips will use a separate, dedicat-

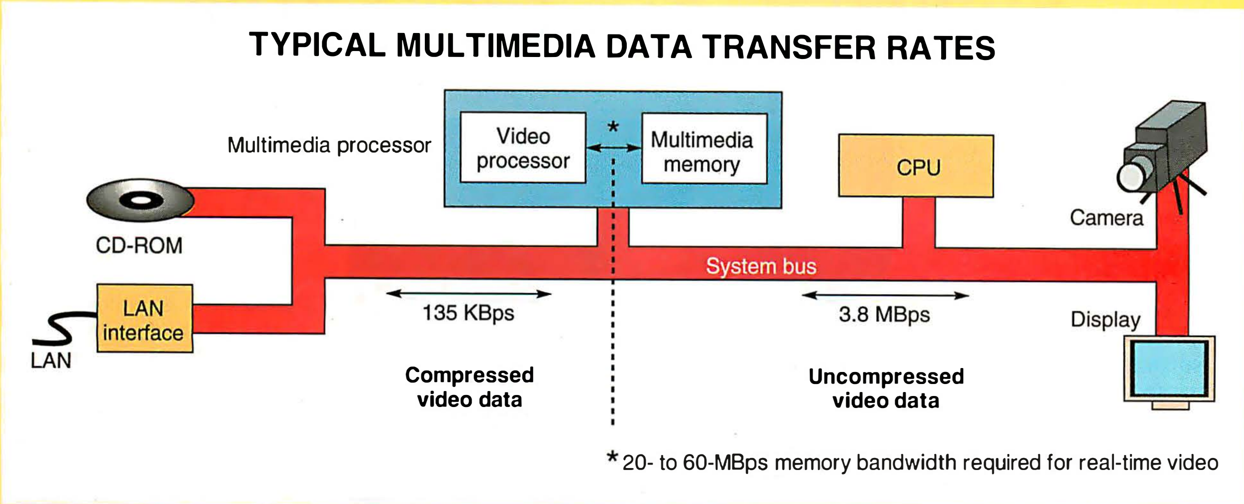


Figure A: *Multimedia processing moves data over the system bus in both compressed and uncompressed formats. The values given here are typical for one-way transfers on a single video stream. Applications such as video conferencing will require the system to simultaneously handle two streams of video information, doubling the bus traffic shown here.*

ed block of memory (typically 1 to 2 MB in size) to store video frames and intermediate data created during the encoding and decoding processes. In the future, however, the trend will be to eliminate this separate memory store and use a portion of system memory for video and related data.

Although this use won't have a significant impact on memory size in 32-bit systems, it will adversely affect memory performance. The memory bandwidths required to process MPEG images are in the range of 40 to 60 MBps for compression and 20 to 30 MBps for decompression. MPEG-2 processing will almost quadruple that memory bandwidth requirement.

Moving to More Colors

To properly present video and photographic-quality images, the frame-buffer depths must increase from the 4 to 8 bits per pixel used today to between 16 and 24 bits per pixel. Full photographic-quality displays require 24 bits per pixel—8 bits each for the red, green, and blue color components.

A 16-bit-per-pixel RGB format can display photographic-quality images with good but not perfect quality. Dithering is often used to eliminate contouring in the image. This is accomplished by masking the image with low-level noise.

Because most GUIs used today (e.g., Windows) store off-screen images in system memory, the storage and bandwidth requirements for GUI image data will increase by a factor of two to four as the frame-buffer depth increases.

Massive Storage

The primary impact of multimedia on the mass-storage system will not be the size of the motion-video files. They are large but not unreasonably so, considering current trends in mass-storage density. Rather, the major impact will be in the performance sensitivity of continuous data types.

In particular, video and audio capture and playback are very sensitive to the continuous data rate and latency (as visible to the application) of the mass-storage device. If the video or audio data stream is interrupted, the resulting glitch in the playback is immediately noticeable.

You can manage interruptions in data delivery from the storage device by buffering the compressed data. This technique, however, introduces additional latency that can reduce the device's responsiveness.

What About CD-ROM?

Although CD-ROM has a very attractive distribution cost per bit, it will only be useful in a subset of potential multimedia applications because it's a read-only device. In the enterprise computing environment of tomorrow, many of the databases containing reference material, application help, tutorial files, and multimedia clip art will be moved to a file server as a network resource.

The most common local mass storage will continue to be high-capacity and high-data-rate read/write devices. Improvements in operating systems and drivers will be required to provide high data rates, continuous streaming, and low latency at the application level.

Pushing the Envelope

The integration of rich multimedia data types into the desktop computer will change our lives. Over the next several years, the systems architecture of the personal computer will undergo significant changes to incorporate these new data types.

The inclusion of video data, in particular will affect memory and mass-storage requirements because of video's continuous nature and large file sizes. Increases in image resolution and the requirements for multiple, simultaneous video streams will continue to push the capabilities of memory and mass-storage subsystems throughout the next decade.

David Sprague is manager of video processors at Intel's multimedia products operation in Plainsboro, New Jersey. You can reach him on BIX c/o "editors."

Floppy—But Very Large

Once the only form of direct-access storage available for personal computers, floppy disks have become relatively less important in recent years than hard and optical disks. In the past, floppy disks were used for everything—program and data storage, archiving, software distribution, and data transport. Today, hard disks, tape, optical storage, and network servers have usurped most of these functions. Software distribution is the only area in which floppy disks still dominate.

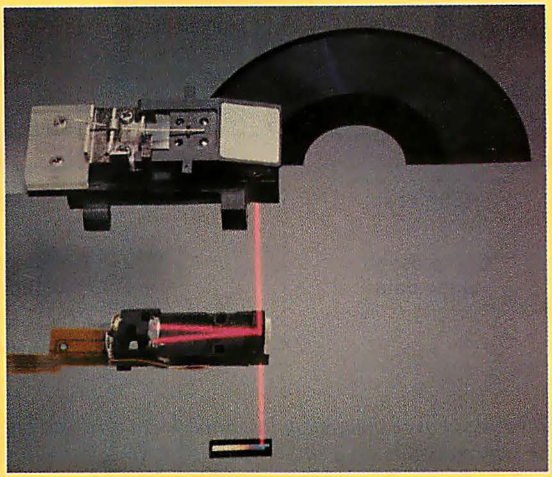
The problem isn't that floppy disks haven't increased in capacity over the years. On the contrary, they have shown a steady progression in capacity, from the 160 KB you got with the original IBM PC floppy disks to the 2.88 MB you can get today.

The problem is that floppy disk capacity has not kept pace with the massive size requirements of today's tasks (e.g., hard disk backup and program and data storage). In a world of hard disks that offer 100-MB capacity and word processors that take up 15 MB of storage space, a 1.44- or 2.88-MB floppy disk isn't terribly useful.

To enlarge the capacity of a disk, you can increase the linear density, the track density, or both. Increasing linear density means putting more bits on a track. Increasing the track density means cramming more concentric tracks into a limited area.

Increasing linear density was the tactic used to increase the capacity of 3½-inch floppy disks from 720 KB to 1.44 MB, and from 1.44 to 2.88 MB. In the latter case, Toshiba used a higher coercivity medium, barium ferrite, to double the number of bits you can store on each track. The Toshiba technology stores about 35,000 bits per inch.

The second method of enlarging disk capacity—increasing track density—has not yet been applied to floppy disks. With high track densities, you need a mechanism that will detect when the head is not aligned exactly over a specific track. This requires a feedback mechanism that enables the drive to read positioning information directly from the medium. The lack of medium-based positioning information and a feedback mechanism is the reason why today's floppy disks are stuck at 135 tracks per inch.



This Floptical drive system uses optical elements to split and focus the positioning light beam. One beam is directed upward to the disk while the other goes to the linear encoder, which contains the pattern needed to determine the position of the low-density read/write head over the tracks of 720-KB and 1.44-MB floppy disks. Both beams are reflected to the quad detector. If the Floptical pattern is detected, the digital servo mechanism uses the information from the first beam to position the high-density head; otherwise, it uses the information from the second beam to position the low-density head.

Making Tracks

Several companies have been working to develop technologies to increase the track density (and thus the storage capacity) of 3½-inch floppy disks. Brier Technology and Insite Technology have succeeded in boosting the capacity of floppy disks to over 20 MB.

The Brier Flextra system uses a low-frequency magnetic signal embedded in the medium to position the read/write head precisely over the intended track. Data recording uses higher-frequency signals, permitting the head to distinguish positioning information from data. The one drawback to the Brier drive is that it can't read and write lower-capacity floppy disks.

The Insite drive uses optical techniques to position the read/write head over the proper track. The medium is embossed with servo tracks that create areas of higher and lower contrast. A light beam reflected off these tracks can find the necessary position of the read/write head over the medium. The use of optical positioning techniques gives this technology its name: Floptical. This technology has one advantage over Flextra: It can read and write conventional 720-KB and 1.44-MB floppy disks.

The Floptical system directs the positioning light beam to the servo tracks on a Floptical disk. When the detector senses the reflected pattern of a Floptical disk, it uses the beam to obtain positioning information. When it doesn't sense the Floptical pattern, indicating the presence of a non-Floptical disk surface, it switches to an alternative positioning system for the lower-density medium (see the photo).

Floptical technology uses magnetic recording technology to actually read and write the data; optical technology is used for positioning only. In fact, the Insite technology uses two heads: one for Floptical disks and one for conventional media. Because its read/write mechanism is larger than the Flextra's, an Insite drive has a seek time about twice that of the Flectra.

Setting Standards

To be more than niche technologies, the Flextra and Floptical drives require the support of media makers, OEMs, and customers. Quantum sells Flextra drives under the QuadFlextra name, and Verbatim makes Flextra media.

Insite has gone further in lining up industry support for its Floptical technology. Early on, the company licensed its technology to Iomega to provide a second source of Floptical drives, lined

up media makers 3M and Maxell, and arranged to have MKE manufacture its drives. Last year, these companies formed the Floptical Technology Association (FTA) to promote Floptical technology and maintain compatibility across media and drives from different manufacturers.

Since last spring, the FTA has garnered support from four SCSI adapter makers, including Adaptec, and from numerous drive OEMs, including Prima Storage Solutions, Liberty Systems, Commodore Technology, Honeywell IAC, and Procom Technology. The FTA believes the ability of Floptical drives to read conventional floppy disks will attract enough OEMs and customers to create a de facto standard.

Handicapping the Race

At more than 20 MB, the capacity of Flextra and Floptical drives is sufficient to enable floppy disks to retain their preeminence as a medium for software distribution and to once again handle applications such as hard disk backup, data transfer, and program and data storage. The final determination of viability, however, rests with the customer.

Given its wider range of support among different companies and its backward compatibility with older media, Floptical technology stands the best chance of establishing itself as the standard for high-capacity floppy disks, but Flextra technology is not standing still.

Brier has announced a 50-MB version of Flextra that will be compatible with 720-KB, 1.44-MB, *and* 2.88-MB floppy disks. In addition, Flextra's overall performance is better than Floptical's, and that will attract customers to whom compatibility is a secondary issue.

The biggest question concerning very high capacity floppy disks is not which will establish itself as a standard, but whether either—or some other design—can succeed in the marketplace. The answer lies with you.

memory can defeat the purpose of a high-speed memory system.

If you paid a premium for a machine with fast primary and secondary caches, you should think twice about using virtual memory to extend your system's memory capacity. An access to a hard disk location is about 200,000 times slower than an access to a main memory location.

On the other hand, virtual memory can be a lifesaver if your need for memory outpaces your ability to pay for it. With virtual memory, as with other aspects of a memory system, you have to balance the benefits against the penalties.

Disk Revolutions

The line between main memory and direct-access storage is the most significant one in the memory pyramid. Across this divide, access speed drops by a factor of several hundred thousand.

More important, direct-access storage is the first nonvolatile type of memory on the pyramid. You don't lose the contents of direct-access storage when you turn off the power on your system. These two factors determine the future evolution of hard disk technology, the most important current form of direct-access storage.

The most significant trends in hard disk technology today are increased capacity and security. Speed is important, but given the enormous gap between disk- and memory-access times, none of the advances on the horizon are likely to have much impact on the relative speeds of drives and memory.

The name of the game in hard disks now is capacity. This is especially evident when you consider the storage-hungry technologies (e.g., multimedia) that are growing in importance on the desktop (see the text box "How Will Multimedia Change System Storage?" on page 164).

Capacity is a function of how tightly you can pack individual bits together on a track (i.e., linear density) and how closely you can pack tracks together on a disk surface (i.e., track density). Both these measures—and their combination, termed *areal density*—are primarily determined by the materials used to construct the disk.

Formerly, hard disks were coated with a crystalline form of ferric oxide called *gamma ferric oxide*. Particles in the coating were magnetized in the direction corresponding to the magnetic field created by the read/write head.

As the need for more tightly packed bits and tracks increased, so did the need for newer coatings. Ferric-oxide coatings reached their limits; they were too coarse to permit the bit information to be packed any more tightly.

THE CPU/MEMORY GAP

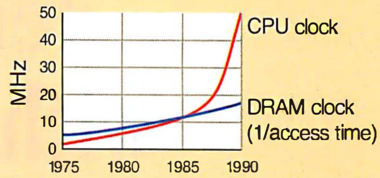


Figure 2: *The curves representing clock speed and memory speed have diverged markedly since the introduction of personal computers in the mid-1970s. This divergence points out the need for caches and other bandwidth-expanding techniques that let memory systems keep up with modern processors.*

Today, most high-capacity hard disks use metallic thin-film coatings that let you pack the magnetic spots extremely close together. A typical high-capacity disk might have a linear density of about 60,000 bits per inch and a track density of between 1500 and 2000 tracks per inch.

Tightly packed recording spots increase both the difficulty in distinguishing one spot from another and the chance that nearby spots may alter a spot's polarity. To overcome the first difficulty, drive manufacturers have long used thin-film heads, which are more sensitive than monolithic ferrite heads.

Keeping one spot from influencing the polarity of another requires the use of materials with high *coercivity* (i.e., the measure of a material's innate resistance to changing its magnetic orientation). Using highly coercive thin films solves the polarity problem, but it introduces another. Highly coercive materials require a powerful induction field from the read/write head to change their magnetic orientation. Keeping this field from making unwanted changes in nearby spots requires a read/write head with a small inductive gap. A small gap, in turn, means that the head must travel very close to the medium, increasing the danger of a head crash.

Increasing the capacity of magnetic disks requires quite a balancing act. Each increase in track or linear density resulting from advances in the materials used requires corresponding advances in the read/write heads and in the servo mechanisms that control them.

Despite these difficulties, the growth in disk capacities will continue unabated for the foreseeable future. For example, Hitachi is already investigating the use of materials that will permit linear densities of 120,000 bpi, and IBM is researching

Terabyte Memories with the Speed of Light

RICHARD MARLON STEIN

The mechanical speed of current mass-storage systems has not kept pace with silicon advances. The I/O bottleneck arising from this mismatch severely limits expedient access to vast data archives that need distillation for research or business purposes.

Within the next seven to 10 years, three-dimensional optical-based RAMs will emerge. With an I/O bandwidth exceeding 1 terabit per second, 3-D ORAMs will eventually replace huge disk farms and other mechanically dependent mass-storage structures.

The theoretical storage-density limit for a 2-D medium (e.g., an optical disk) is $1/\lambda^2 = 4.0 \times 10^8$ bits/cm^2 or 50 MB/cm^2, assuming a 0.5-micrometer (10^{-6}-meter) illumination source to address the information. For 3-D storage (e.g., a 3-D ORAM), the theoretical storage density limit is $1/\lambda^3 = 8.0 \times 10^{12}$ bits/cm^3 or 1 terabyte/cm^3. With 20,000 times the theoretical storage density of 2-D media, the 3-D ORAM technology clearly has a substantial advantage in capacity.

The 3-D ORAM prototypes currently under development at the University of California at San Diego and at Irvine use a small cube (1 cm^3) of material composed of transparent styrene doped with a light-sensitive chemical (see references 1, 2, and 3).

When two polarized, coherent, and orthogonally oriented light beams simultaneously strike the material, a bit is recorded at their intersection in the form of an opaque dot, or pixel. The finer the light beams are, the smaller the bit becomes. The light beams can be focused to 1 micrometer, resulting in a recording density over 1000 times that of optical disk media.

Unparalleled Bandwidth

Access speed is another important characteristic of storage systems. The typical hard drive consumes about 10 milliseconds during armature and head movement before reaching an arbitrary location for reading or writing.

DRAM is much faster than a hard drive, with a cycle time approaching 80 nanoseconds. Static RAM is faster still, with cycle times in the range of 20 ns, but it's also more expensive.

In contrast to these relative infinities of time, you can read or write 3-D ORAM in as short a time as 10 to 20 picoseconds (10^{-12} seconds). This is over 1000 times faster than conventional semiconductor memories.

Furthermore, you don't access 3-D ORAMs to read or write from 1 to 32 bits at a time, as you do with standard silicon memory chips and microprocessor subsystems. You write 3-D ORAMs in a highly parallel fashion, simultaneously accessing 1 million bits of data or more in each cycle (about 1 microsecond).

To put these figures in perspective, I'll compare them with the total memory bandwidth of a parallel-processing system containing 1000 processors, such as the newly announced CM-5 from Thinking Machines (Cambridge, MA). Assuming a 64-bit word cycle and an 80-ns memory cycle, a total memory bandwidth of 100 gigabytes per second would be possible for the 1000-processor parallel-processing system. A single 3-D ORAM can address 1 Mb every 5 µs, for a memory bandwidth of 25 GBps.

3-D ORAM ACCESS

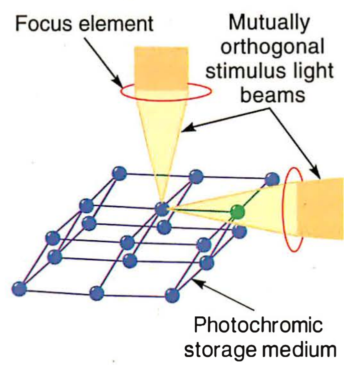


Figure A: *3-D ORAMs record information through the excitation of a photochromic chemical dopant. To read a bit, two photons of 1.03-micrometer wavelength provide the necessary stimulus when they strike a data bit.*

Storage Through Chemistry

The storage medium for 3-D ORAMs records information through the excitation of a photochromic chemical dopant called *spirobenzopyran*. When this molecule absorbs two photons of 0.538-micrometer wavelength (visible light) simultaneously, it changes color (much like light-sensitive sunglasses that darken on exposure to direct sunlight) and records a bit (see figure A).

To read a bit, two photons at the infrared wavelength of 1.03 micrometers provide the stimulus by striking the pixel. The read process is nondestructive, and the data remains intact.

The material used to store the information is susceptible to environmental conditions. The bits can randomly flip when exposed to room temperature, destroying the information content. When immersed in liquid nitrogen or dry ice, 3-D ORAMs can retain their information for weeks. Eventually, a more durable chemical dopant will be found that can withstand temperate environments without losing data.

Address of Exotic Ingenuity

The eventual incorporation of the 3-D ORAM technology into standard computing systems hinges on the emergence of practical address-control mechanisms. DRAMs have chip-select and output-enable lines that control the dissemination of data and access to any

point in memory. A 3-D ORAM requires analogous support and control circuitry. The control lines are not fashioned from copper wire, and the signals are not electrical: They are electro-optical.

A key element of the address-control mechanism is the dynamic focusing lens, which contains filters stored as holographic images. Each filter selectively interferes with the output light field emanating from a 2-D array of pixels. This array is illuminated by a coherent light source (a laser) tuned to the storage medium's read or write wavelength. The DFL may contain several dozen holographic filters.

The filters continuously cycle, like the flickering frames seen in old moving pictures, but the holographic frames flash by at 1 MHz, not 24 Hz. The DFL cycle speed provides the limit of the speed at which information can transfer into and out of the 3-D ORAM. The filters are constructed from random-phase holograms, and the 3-D images they project do not resemble the neat creatures seen in *Star Wars* or those built by the MIT Media Lab.

As each plane of pixels (i.e., a planar slice through the storage medium) is illuminated, the current DFL filter permits a select portion of the 1 million or more visible pixels to pass through. A detector assembly registers them as bits of data. Each time a new DFL filter is active, a unique area of the pixel array is mapped onto the detector and assigned to semiconductor RAM for processing.

The detector may consist of an array of 256 by 256 photo transistors, like those used to convert fiber-optic Fiber Distributed Data Interface signals into electrical impulses for electronic digital processing.

Because a detector organized as 256 by 256 elements contains 65,536 elements, the DFL maps 1 million pixels (1 megapixel) simultaneously into the detector array. It uses a multiplexing process strobed to the holographic-filter cycle. Mapping a 1-megapixel plane into a 65,536-detector array requires the DFL to store 16 unique holographic patterns.

The detector assembly may eventually be fashioned from thousands of microlasers, each about 2 micrometers in diameter (see references 4 and 5), rather than discrete photo transistors.

Right Write

One additional element of the electro-optical address-control mechanism is an active device called a *spatial light modulator*, which alters the polarization of the light beams used to write the pixels. When the two incident light beams intersect, the amount of energy they deposit at a particular pixel address in the storage medium is determined by the superposition of the polarized photons. At that point, the SLM alters the light-beam polarization to achieve a constant intersection amplitude, making certain that a bright pixel is written.

Constructed from liquid crystals and a combination of rare earth metals (e.g., zirconium and lanthanum), the SLM element is a vital component that contributes to the success of the 3-D ORAM.

Ponderous Implications

The projected cost for 3-D ORAM with terabyte capacity ranges from $10 per MB for a 1-µs access cycle to 10 cents per MB for a 100-µs to 1-ms access cycle. A terabyte of storage with 3-D ORAM ranges in cost from $10 million for a 1-µs access cycle to $100,000 for a 100-µs to 1-ms access cycle. Compared to DRAM, which ranges from $100 per MB to $30 per MB for an 80-ns access cycle, 1 terabyte of DRAM would cost $30 million.

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magnetoresistive heads that will let you access nearly 2 Mb per square millimeter.

The next few years will also see advances in disk subsystems, which will sport more intelligent controllers (see "Embedded Intelligence" on page 195). You will also see more fault-tolerant disk subsystems. Technologies such as redundant arrays of inexpensive disks and Compaq's Intelligent Drive Array will ensure that you will not be caught off guard if your multigigabyte disk system goes on the blink.

Another important form of direct-access storage over the next few years will be optical read/write storage that uses magneto-optical technology. MO drives feature removable media that let you move a disk from one machine to another. Although plagued by incompatible media in the 5¼-inch format, developers hope that adherence to a common 3½-inch format will make MO technology more attractive.

MO technology is best suited to situations that require high capacity without high-speed access. Optical read/write heads are more massive (and slower) than magnetic heads. Even though you wouldn't want your database server to use MO disks, less time-critical applications can make good use of their large storage capacities.

One last direct-access technology that could have an important impact over the next few years is solid-state disks. These are actually not disks at all but simply DRAM that emulates a drive and has its own power supply. Solid-state disks are much faster than conventional disks because they are completely electronic. They sometimes come with a conventional tape or drive to back up the DRAM.

Although solid-state disks have a place in situations where speed is everything, don't expect them to cross the price/performance threshold that would make them more attractive than magnetic media. Most people who predict the imminent demise of magnetic media discount the evolving nature of the technology.

If magnetic media were not making progress, you could make a case for the widespread acceptance of solid-state media, but that isn't the case. More likely, you'll see greater use of caching controllers to improve access times for magnetic media. This is the most important contribution DRAM technology can make to disk performance.

Gathering and Dispersing

As more workgroups, departments, and companies adopt networking technology to link individual workers, protecting data from accidental or malicious loss becomes increasingly important. Magnetic tape will

remain the technology of choice for the archival protection of information. The struggle among different formats (e.g., quarter-inch cartridge and 4-mm and 8-mm tape) will ensure increasing capacities and decreasing prices.

What will be different in archival storage in the future will be the intelligence of the backup systems. Archival systems will be integrated into a comprehensive storage management system that automatically makes frequently accessed files readily available and stores less frequently used files on slower media (e.g., tape or WORM drives).

Such a scheme makes the best use of faster, more expensive direct-access media while retaining access to information that is not often needed. This kind of intelligent distribution of backup is especially important in networking situations, where you can easily overburden a file server.

One of the primary causes of the growing need for more main memory and direct-access storage is the sheer size of the program and data files that today's applications require. The search is under way for a more efficient and effective way of distributing programs and data.

Given the size of current applications—with their attendant tutorials, help files, printer drivers, and so forth—it isn't unusual to find a dozen floppy disks in an application package. This increases the cost of the package and makes installation more prone to error.

Recently, some companies have tried a number of alternatives to floppy disk–based distribution. When first introduced, the Next machine came with a standard MO drive, and many companies, including Next, distributed software on compatible MO disks. The lack of an MO standard format and the absence of any significant market penetration by MO disks in general make this form of distribution of questionable value for the industry at large.

A more promising technology for program and data distribution is CD-ROM. Unlike MO, the CD-ROM has a strong foundation of data-format standards that are recognized industrywide. Thus, you can be reasonably certain that your CD-ROM drive (no matter what its make) will be able to read CD-ROM disks, given the proper interface software and driver.

Companies such as Apple and Microsoft have taken advantage of the standardization in CD-ROM players by distributing systems software to developers on CD-ROM. Unix software publishers are also turning to CD-ROM in increasing numbers in preference to the more traditional tape-based distribution.

Presently, CD-ROM is best used as an information-distribution medium. With a capacity of over half a gigabyte, it is the preferred medium for distributing data-intensive applications. The availability of large databases is driving the broad penetration of CD-ROM drives in the marketplace, which will further spur the use of CD-ROM by traditional developers.

Other storage media commonly used for data distribution are magnetic tape, WORM, and removable hard disks, such as those made by Iomega. The problem with these media is the same lack of standards that plagues MO technology.

In the future, wide-scale distribution of programs and data will remain the province of floppy disks and CD-ROM. Recent advances in floppy disk technology will make it more attractive for this function (see the text box "Floppy—But Very Large" on page 166), and new, higher-capacity CD-ROM standards will greatly add to the utility of this technology.

Adherence to the new standards for 3½-inch MO media may avoid the polyglot of formats that crippled larger MO formats as a distribution medium and add MO technology to the list of widespread distribution media as well.

Storage Plus

The next few years will see the introduction of 16-Mb DRAMs, 2½-inch hard disks with capacities exceeding 250 MB, standardized MO formats, and perhaps a new CD-ROM format. More important, you will see increased complexity in the bandwidth-enhancement schemes used to keep processors running at capacity. The recent announcement from DEC that it is clocking its new Alpha RISC chips (manufactured on its standard production line) at 200 MHz underscores the importance of techniques that keep pipelines full.

In the future, you may see entirely new forms of storage emerge for desktop systems. The most promising of these alternative technologies is holographic storage, which can not only store incredible quantities of data but also avoid bandwidth problems by eliminating buses entirely (see the text box "Terabyte Memories with the Speed of Light" on page 168).

Semiconductor memory and magnetic direct-access storage will continue to dominate the memory pyramid. Faster and higher-capacity generations will be produced to keep up with the bandwidth requirements of processors. In the end, however, it will be the intelligently designed and executed memory systems that will keep processors from gasping for data. ■

Bob Ryan is a BYTE technical editor. You can reach him on BIX as "b.ryan."

Before You Upgrade To MPC, Listen To This.

BYTE

USER'S COLUMN

Sound Blaster
One of the boards we installed in the Arche 486 was Sound Blaster. With its associated software, it has quietly (no pun intended, but what the heck) become the standard sound system for advanced PCs. The Roland board has much higher sound quality for a higher price, but for anything short of professional music quality, Sound Blaster is good enough. One use, of course...

There are lots of other accessories you can get for Sound Blaster, including musical instrument software and a voice editor. Sound Blaster has become the standard sound board, if not for the industry, at least here at Chaos Manor. Recommended.

Jerry Pournelle

PC GAMES

SOUND BLASTER PRO

By Barry Brenesal

The Marines may look for a few good men, but any PC game player will gladly settle for a single good sound card: one that plays both Sound Blaster and AdLib scores, one that doesn't fry your other boards, one that never draws attention to itself, one that delivers all the sophisticated sound effects and music bundled into the latest batch of game software.

Look no further: Sound Blaster Pro does it all, and more. At $299.95 it's not cheap, but neither are its features.

Testing: One, Two . . .

Installing Sound Blaster Pro is a snap. The 16-bit card slips easily into place. It comes with a test...

Trying out Sound Blaster Pro is a treat. It's got great frequency response — that's the difference between listening to a film score on a tinny, muffled AM radio and hearing it on a stereo movie-theater speaker system. The orchestral soundtrack to Origin's Wing Commander is a good example, because it changes mood and melody to match the success of your current battle. Add Sound Blaster Pro to a good VGA screen and a responsive joystick (which you can plug into Sound Bla ter Pro's joystick port), and the illusion of dogfighting aliens in a George Lucas-style film becomes 3-D, symphonic reality.

Another plus is the absence of the annoying background hiss...

In short, Creative Labs' Sound Blaster Pro is a big winner. It's quick to install, easy to use, full-featured, and compatible with Sound Blaster and AdLib files. Signal response is excellent. And don't forget...

COMPUTE

SNEAK PEEKS

SOUND BLASTER PRO

In just two years, the Sound Blaster has become one of the the most widely-supported PC sound cards. It's easy to see why. The Sound Blaster contains an 11-voice FM synthesizer that makes it fully compatible with the popular Ad Lib Music Card. The day it hit store shelves, the Sound Blaster could be used with hundreds of Ad Lib compatible games and educational programs. To add even more value, the original Sound Blaster included a DAC (Digital to Analog Converter) for digitized voice and sound effects, a microphone jack for voice input, a built-in game port, a built-in 4-watt amplifier, and an optional MIDI interface.

The built-in mixer makes the Sound Blaster Pro fully compliant with Microsoft's Multimedia Level 1 Extensions to *Windows*. Multimedia software will be able to fade-in, fade-out, and pan the various audio sources to create elaborate sound montages.

The Sound Blaster Pro includes a CD-ROM interface for either an internal or external CD-ROM player.

There's also an internal connector for CD-Audio. The MIDI interface is compatible with the original Sound Blaster's MIDI interface, but adds the MIDI time-stamp that's part of Microsoft's new multimedia standard.

All in all, the Sound Blaster Pro is chock-full of new features, yet it's fully compatible with its younger brother.

DAVID ENGLISH

Scheduled Release: September 1991
For IBM PC and compatibles—$299.95

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PC HOME JOURNAL

SOUND BLASTER DOES IT ALL

Review by Harvey Bernstein

The Sound Blaster has so many audio applications packed into one half-sized board that it almost boggles the mind. First, it has an 11-voice stereo music synthesizer that is fully compatible with the widely used AdLib sound format. Older software that only supports the AdLib board will automatically turn on the AdLib mode — no adjustment by the user is necessary. A separate channel is exclusively for reproducing digitized speech. A microphone jack on the back of the card allows you to digitize your own input voices. With a 4-watt stereo amplifier built in, you can run speakers or headphones directly from the card — no additional amplification is necessary. A standard joystick port also doubles as a MIDI interface, allowing you to connect a synthesizer or any other MIDI instrument. Combine this with an excellent library of software, and it is easy to see why the Sound Blaster has become so popular.

...is the Sound Blaster worth the investment? Yes, yes, a thousand times yes!!! When you hear how much the Sound Blaster increases the capabilities of your PC, you'll wonder how you ever got along without one.

Now you can get the number one sound card as part of our new Multimedia Upgrade Kit. Which also comes with a MIDI kit, an internal CD-ROM drive and 5 CD-ROM titles, including Microsoft® Bookshelf® and Windows™ with Multimedia Extensions. In all, $2,000 worth of goodies for just under $850.

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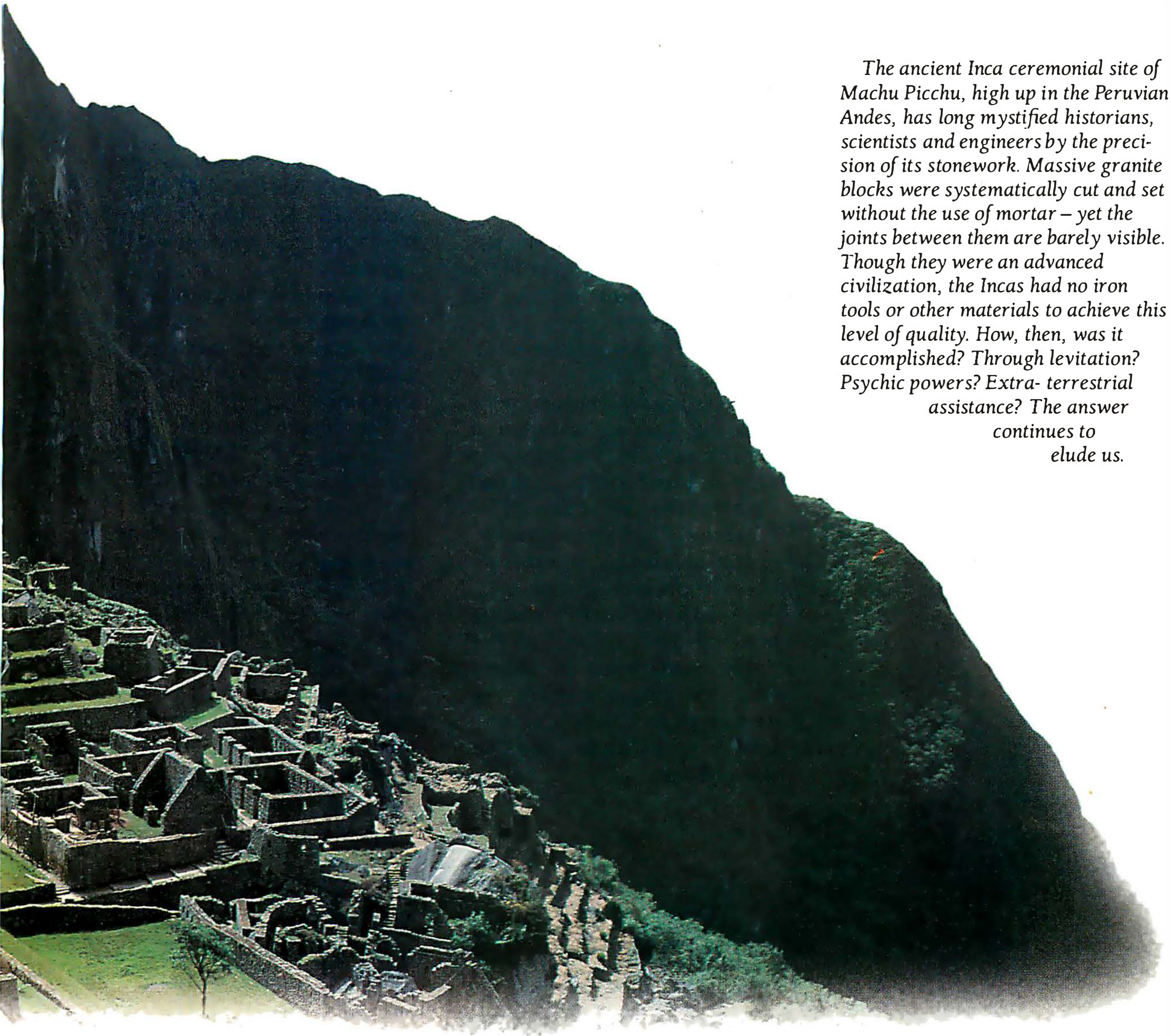
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To keep your network operating at factory specifications, Northgate offers comprehensive service and support plans. We provide 24-hour toll-free telephone Technical Support 365 days a year. And our technicians are backed by Certified NetWare® Engineers. To top it off,

The ancient Inca ceremonial site of Machu Picchu, high up in the Peruvian Andes, has long mystified historians, scientists and engineers by the precision of its stonework. Massive granite blocks were systematically cut and set without the use of mortar – yet the joints between them are barely visible. Though they were an advanced civilization, the Incas had no iron tools or other materials to achieve this level of quality. How, then, was it accomplished? Through levitation? Psychic powers? Extra- terrestrial assistance? The answer continues to elude us.



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WHAT TO STASH IN A CACHE

Caching holds the key to system performance

STEVEN J. VAUGHAN-NICHOLS

Everyone talks about MHz and million instructions per second, but CPU speed, no matter how you measure it, isn't really a good guide to system performance. Even a rocket-fast 50-MHz 486 can be hamstrung by poor data throughput. The fastest CPU in the world can go only as fast as its data flow allows.

Today's hot chips run into two data-throughput problems. First, memory hasn't kept up with the CPU. Memory chips with 60-nanosecond access times may sound fast to you, but even a 25-MHz 486 can be left gasping for data by these chips. The second headache is that secondary storage (e.g., hard drives and floppy drives) is far slower than memory. The best raw access time you can expect from commercial products is about 9 milliseconds, an eternity for even 68000 or 286 chips.

One Solution

Caching is the solution to both these problems. This has led to some confusion, though, because you're talking about apples and oranges when it comes to implementation.

Memory caching, like that found on the in-board caches of the 486, 68040, and IBM 386SLC, is meant to improve throughput from the chip to the memory. This kind of caching won't significantly speed up disk access.

Disk caching, represented by programs such as Multisoft's PC-Kwik and drive-caching controllers like Perspective Solutions' HyperStore 1600, is another story entirely (see the text box "Software or the Controller?"on page 178). Software uses a portion of main memory to speed disk accesses, and caching controllers make use of



ILLUSTRATION: LES KANTUREK © 1992

dedicated on-board memory for the same purpose.

It Looks Like a Cache

Not everything that looks like a cache deserves that title. Each of MS-DOS's buffers, for instance, is a 512-byte storage area for data shuttling back and forth from the memory to the disk. MS-DOS's buffers also hold disk file-table and directory information.

Buffers, however, use little intelligence in managing the information that flows through them. Relying on the first-in/first-out (FIFO) concept, DOS buffers are almost too simple to be caches. There's no hard-and-fast rule on the difference between buffers and caches, but a good rule of thumb is that caches manage data and buffers merely store data.

Not all disk drive controllers with static RAM have real caching. Some have a 16- to 64-KB SRAM storage area that is used only as a high-speed buffer. Other controllers add more oomph to their data-handling abilities by adding read-ahead capabilities. Many IDE drives include this performance booster in their bag of tricks.

With read-ahead capabilities, the controller reads not only the sectors containing the data called for by the CPU, but additional sectors from the same track. This method of disk I/O relies on temporal locality. When possible, most operating systems write information sequentially on a disk's tracks. This improves the chances that, by reading ahead, the controller's cache will contain the data that the processor will need next. More advanced buffering controllers (e.g., the Western Digital WD1009V-SE2 and the Adaptec ACB-2322D) buffer entire tracks of data.

Cache Design

To make more sophisticated caches, designers must juggle a bewildering array of considerations. There's a good reason there are so many different cache programs and hardware: There are no easy answers to the question of how to build a cache. Take, for example, that favorite cache bromide: Bigger is always better. Wrong. Bigger caches are usually better, but not always.

The data-set model demonstrates that increasing the cache's size results in a significant increase in performance at first. However, as the cache starts to become large enough to hold an entire data set, its performance-rate increase slows dramatically.

This phenomenon occurs for several reasons. Some are purely implementation matters. For instance, the cache program's processing overhead can begin to impact the cache's overall performance. Good cache management algorithms aren't small in terms of space or processor requirements.

A more fundamental problem is that a cache can become so large that more time is spent pulling information from it than would be taken digging the data out of memory. There really can be too much of a good thing, and overlarge caches are a perfect example.

Bigger Is Not Necessarily Better

Other ingredients in cache recipes are data tags and data lines. In the most common type of cache, data is arranged using the set-associate model. In this paradigm, a cache is divided into at least two parts: data-tag space (sometimes called the cache directory) and data-line space.

Data-tag space holds the data tags, and it's like the cache's phone book. By quickly running its figurative finger down the data tags, the cache controller can quickly find the location of the desired data. These tags are connected to their matching data lines by pointers or linked lists. Each tag usually holds the base address to a set, or block, of data lines.

Data lines hold the cached data. These lines vary in length, but they are usually a multiple of the maximum word size that a processor can handle. A 386 processor's data lines, for instance, could be no smaller than 4 bytes, because the 386 is a 32-bit processor.

The longer data lines are, the more efficient the cache is. In a 32-KB cache, 32-byte data lines work far better than 4-byte lines. This works for the same reason that larger caches work better: Longer lines hold more data. In terms of the working-set model, longer data lines increase the spatial locality of a working set.

Alas, longer data lines aren't a panacea for building efficient caches. There's no rule that determines the proper blend of cache size and data-line length. For a fixed cache size and a given work load, it's difficult, but possible, to calculate the ideal data-line length. It's not an ideal world, however, and cache designers sweat blood trying to balance cache size and data-line length to make the best possible cache.

Fetch for the Cache

When a cache starts up, it contains no data; the cache is in a cold-start state. As programs call for data, the cache begins to fill up, and its effectiveness increases. Cache controllers decide what data will be fetched into the cache by one of two schemes.

Demand fetch is the first of these approaches. It is only when the CPU demands data that the cache does not contain that the cache controller goes to main memory or secondary storage for the information it needs. The demand-fetch approach works. It offers the sterling advantage of keeping data fetching simple and stupid. It's not, however, very efficient.

Far more popular are the prefetch designs. The problem here is that there's no crystal ball predicting exactly what information the CPU will require next.

Caches generally do well with flat-memory or contiguous file systems by always fetching the next physically adjacent data element for the cache. If a program calls for data in memory location *x*, the cache will also haul in the data from location *y*. This quick-and-dirty implementation is called one block look-ahead (OBL).

As usual, though, when a solution looks fast and easy, there's a catch. In this case, bus- and memory-traffic overhead is the obstacle that keeps OBL from being an ideal solution. Prefetch schemes that are always moving data out of storage can cause memory- and bus-traffic jams on even the fastest of systems.

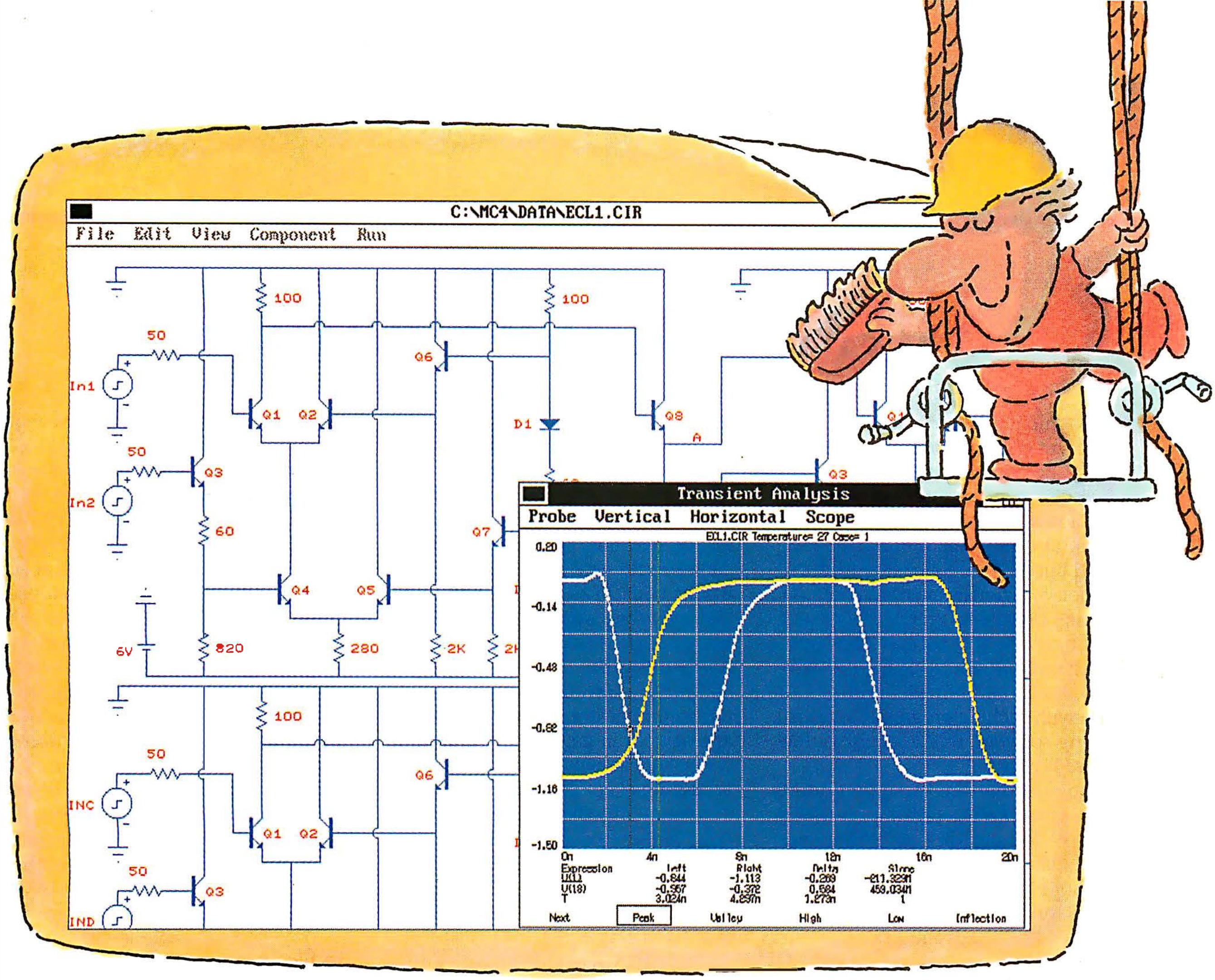
Traffic overhead is not the only problem with constantly prefetching data. By pulling in new data all the time, old data (which may still be needed) can be booted out of the cache.

These problems don't make cache designers happy. One of their responses has been to make caches prefetch data only after the controller can not find it in the cache. This approach alleviates the traffic problem, but it produces caches that perform only marginally better than caches without prefetching.

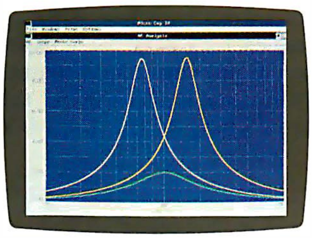
Fortunately, there's a better way. By prefetching data when there's been a hit on a prefetched data line as well as when there's been a miss, cache performance approaches that of caches that always prefetch data. This tagged prefetching works because it enables the cache to more closely model the current working set. At the same time, tagged prefetching has only a fraction of the impact on memory bandwidth as

BYTE ACTION SUMMARY

Many believe that choosing the biggest cache option will guarantee peak performance for their new system. A cache will affect performance, but it isn't always for the better. Caches, systems, and applications must be matched.



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Software or the Controller?

Which is better, cache software or caching controllers? There's no question which one makes more of an impact on your wallet. Caching controllers may give your personal computer a much-needed boost, but they're not cheap. Prices in the thousand-dollar range are common. Caching programs, on the other hand, are sometimes free, because they're included with the operating system. MS-DOS, Unix, and Novell NetWare all come with caching programs. At most, caching software will cost only a few hundred dollars.

Choosing between spending more than a grand for the caching controller or $200 for caching software may sound like a no-brain decision, but it's not. Both hardware and software secondary-storage caching have their advantages and disadvantages.

Soft Cache

Software caches have more than price going for them. With a cache program, you often get control of cache size and behavior. This additional flexibility ca be a great boon. If you have a RAM-hog application dema ding every possible byte, you can adjust the cache size to give the rude application its fill of space. A controller's dedicated memory is untouchable.

Another point in a software cache's favor is that it's temporally closer to the CPU. No matter how fast a caching controller's memory is, its speed is straitjacketed by its need to communicate with the CPU across the bus. A software cache, even though it is located in memory that's usually twice as slow as that in an intelligent controller, can get the data to the CPU faster. For instance, on a system with 70-nanosecond main-memory chips and an ISA bus, an efficient software cache could beat out a caching controller with 25-ns static RAM chips. The slow bus would simply prove to be too high an obstacle for the controller to hurdle.

Finally, a software cache usually improves the performance of all data-storage devices in a system. The caching controller can only effect searches that access attached devices.

It's not all wine and roses for software caches, though. Cache programs take up part of main memory. For operating systems like MS-DOS with only 640 KB of storage for programs, this is not a trifling matter.

Software caches also require their fair share of CPU time. On a lightly loaded system, this isn't a problem. Computers used for CPU-intensive tasks or multitasking may not have spare clock cycles for a cache's demands. The caching advantage of improved throughput will overshadow this problem, but a caching controller would have avoided it altogether.

Hard Cache

The pluses and minuses of controller caches are almost a mirror image of those of software caches. Although hardware caching is far more expensive than its program-bound brethren, its performance is much better than software caching on EISA or Micro Channel architecture bus–based systems.

A controller-bound cache doesn't burden the CPU with its own work or memory management. The CPU can stick to worrying about its programs and not worry about the cache. A side benefit of this is that caching controllers won't cause software conflicts. Software caches ca occasionally clash with other programs, even in single-tasking operating systems. Caching controllers don't have this problem. In the Intel-based world, for instance, almost all caching controllers hide their complexities behind the register-level mask of the industry-standard Western Digital WD1003 controller. No matter what your operating system, your computer should never have any compatibility problems with this approach.

What to Do

Contrary to some reports, there's really little question about when each type of caching is appropriate. Multiuser or multitasking systems, regardless of bus type, should go with hardware caching. Also, systems that demand high performance and have an EISA or Micro Channel bus to match that demand should be equipped with caching controllers. Conversely, ISA or other slow-bus computers will do better with software caching, all other factors being equal. For computers in that gray a ea where their technology a d usage make it debatable which would be the most appropriate upgrade, vote with your pocketbook and go with additional main memory and software caching.

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prefetching only on misses.

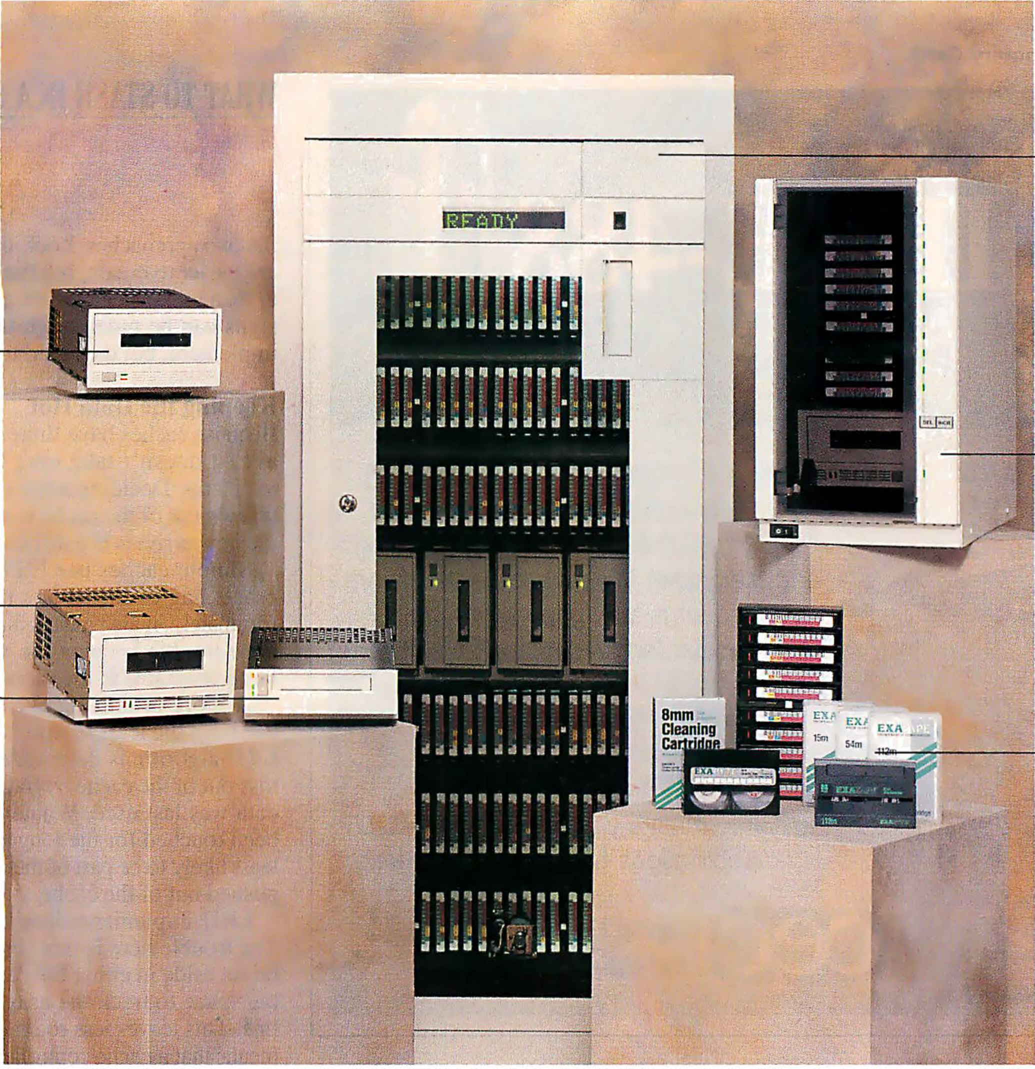
Is tagged prefetching the Holy Grail of cache design? No, it's not, because it, too, has its share of problems. Implementing tagged prefetching requires far more intelligence on the part of the cache program or hardware than its simpler counterparts. Caches that must contend with other programs for the CPU's attention can be less efficient in total system performance than their more stupid cousins.

Another problem is that any prefetching plan is highly sensitive to the data-line length. Usually, long data lines help any cache. With prefetching, long data lines can waste space. Whether tagged prefetching is the ideal solution for a particular cache depends on too many other variables for there to be any easy answer.

Designing Caches

There are three basic cache designs. The first, and the easiest to design, is direct mapping. In direct mapping, the cache's data lines correspond with storage's data addresses on a one-to-one basis. Determining if a particular data element is in the cache takes only a few clock cycles. Either the data is in its cache pigeonhole, or it's not and must be fetched from storage.

This one-to-one correspondence is direct mapping's Achilles' heel. The cache is not as large as main memory, much less secondary storage. Because each cache address line must go to more than one memory location, inefficiency is built into the design. Say that cache data line one is directly mapped to locations *a* and *f*. The cache is able to hold data from only one



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location. When a program calls for data from both locations, the cache program will be unable to cache both *a* and *f*, even if there's a vacancy left in the cache.

The opposite of direct mapping is fully associative caching. In caches of this design, there is no fixed mapping of memory or storage. Instead, cache data lines can be set to map to any memory location.

Sounds great, doesn't it? A fully associative cache should correspond, within the limits of cache space, to the working set. The catch here is that in return for having more of the appropriate data in the cache, the cache takes longer to search.

Remember, in a direct-mapping cache, finding out if a data element is present is a lead-pipe cinch. If the information is not in the cache, the controller doesn't need to waste time looking for it. An associative-cache program must search through the cache's entire tag list before giving up.

What is the best solution? Many designers believe that a compromise, set-associative caches, offer the best general cache performance potential. Set-associative caches can be found in such designs as the Motorola 68040, the Intel 82385 cache controller chip, and the 486.

In set-associative designs, the cache space is divided into two or more separate spaces. The 68040, for instance, uses a four-way set-associative design. Both the 4-KB instruction and data caches are divided into four 1-KB memory areas that contain 64 sets of 16-byte data lines. Each set virtually corresponds to a physical address. In essence, each set is directly mapped to a section of memory. Within each set, though, the data lines are given their data assignments in an associative fashion.

When the 68040 goes in search of data, the memory management unit translates the virtual addresses to physical addresses. Simultaneously, the MMU searches the appropriate cache line set for the data. This can happen because the least-significant address bits are the same for both address types. The result is that you get the benefits of direct mapping's raw speed along with the fully associative cache's ability to closely follow the working set.

Where Has My Data Gone?

One question that frequently comes up in cache design is how a processor should search for data. Many designers support look-through (serial) caches. In this plan, the processor looks in storage for data only after it has made sure that the data isn't in the cache. In the alternative approach, look-aside (parallel) caches, the processor searches both areas at the same time.

Like almost everything else in caching, there are good things and bad things about both of these designs. The problems are symptomatic of the usual trouble between the two approaches. Look-through designs are easier to create, but they can be slower than look-aside designs. Look-aside designs can be much more troublesome to implement, but they tend to be faster.

Keeping the Data Hot

Because caches have finite space for storage, it doesn't take long for that space to fill up. Deciding what data should be thrown out of the cache to make room for the new arrivals is a difficult decision.

Simple caches use FIFO. This keeps processing overhead at a minimum. Unfortunately, it also means that FIFO caches have trouble keeping the working set of large programs in the cache.

A more promising avenue to explore has been the least recently used criterion. LRU algorithms determine what data to toss out of the cache by tracking when the data was last used. Whatever data hasn't been touched for the longest time (and is least likely to be part of the working set) is pushed out of the cache.

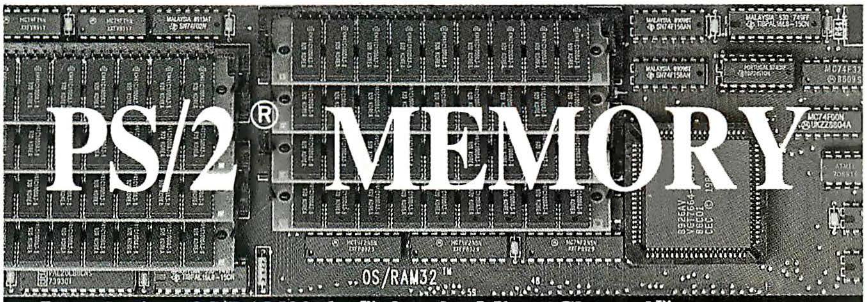
LRU implementations aren't perfect. The trouble here is that some space must be set aside in either the data space or the tag space to track the usage of each data line. This leaves less room for data. It also means that a cache controller, an MMU, or a CPU will be stuck with the job of tracking data-line usage. That leaves less time for other work.

Reading and Writing

Most cache-design issues are hidden from users. One that isn't is the question of when a cache should write its data back to storage. The choices are write-through and several flavors of posted-write. In a way, it's rather curious that this area of caching has been highlighted for public attention. Reads outnumber writes by 9 to 1. Improving a cache's write performance just doesn't make that much difference to overall I/O.

In write-through designs, any data change is cause for the change to be written to data storage. The downside of this simple approach is that it can decrease memory and/or bus bandwidth when other processes need it more.

One variation of the write-through design that addresses the bandwidth issue is the buffered write-through. In these caches, small data writes (usually no more than a few machine words) are put into the hands of the cache controller. The CPU is free to look for its next byte of data. If the CPU finds its data in the cache, the controller writes the changed data to storage while the CPU reads from the cache. When the CPU needs to go to storage, the write is made to storage first (negating the buffered



write-through design's advantage), and the CPU reads from storage.

The posted-write approach gets around potential bandwidth traffic jams by not allowing any writes until the system is relatively idle. There are two ideas on when these writes should occur: always copy-back and flagged copy-back. If a cache implements an always-copy-back approach, all cached data will eventually be written back to storage, even when the data line is unchanged. Flagged-copy-back systems cut down on data traffic by posting only changed data lines to storage.

Some trouble comes with the advantages of these caching techniques. First and foremost, any kind of posted-write caching means there's a discrepancy between the data in the cache and the data in storage. Before DMA, that wasn't much of a problem. Now, though, on many architectures and systems, it's quite possible for a device to make a change to memory without going through the CPU or the cache. Processes can become completely befuddled trying to work with invalid copies of data because there's no easy way to tell which copy is the valid one.

The 68040 (which has five caching modes, including one with copy-back) uses several techniques to combat copy-back's problems. The first is bus snooping, the approach most often used by cache controllers. The 68040 can monitor data inputs on the bus. In the event of a possible data conflict, the chip can bypass memory and either read data from its internal pair of 4-KB caches or take data directly from the bus.

As a second barrier against data corruption, the 68040 employs noncachable serialization. In this particular mode, the CPU skips over the cache for I/O operations that might be hampered by delayed writes.

The concern that weighs on people's minds about delayed writes is what happens if the system goes down. This is a real problem. Some operating systems, Unix most prominently, can cope to a degree with this kind of office disaster. Unix keeps its master file records (i.e., the superblock) in memory, and it updates the on-disk version only when the system periodically runs the `sync` command. Not every operating system has an `fsck` utility that can repair some of the damage left behind when a system failure maroons unwritten data in memory.

No one likes to clean up a system after a crash. The speed gained with delayed writes is too small to justify their use in most circumstances. Only users who need the fastest possible throughput should bother with delayed writes.

Making the Cache Call

Those are most of the parts of the cache puzzle, but how can you tell when a cache is working well? The main objective of any cache is to achieve the highest possible hit rate. The hit rate is determined by how many times the processor finds the requested data in the cache instead of having to go to storage. To merit high marks, a warm-state cache should have a hit rate that averages better than 90 percent.

The hit rate is not the only factor that measures success. An outstanding cache should also be able to send back the data quickly to the processor once it's been found. On the other hand, an exceptional cache should be able to report quickly when the data isn't present in the cache. This last factor is what usually trips fully associative caches.

With all these factors to consider, you might wonder how anyone ever builds a cache in the first place. One trick up cache designers' sleeves is to use cache-simulation programs. The Dinero III cache simulator, a freeware program by Mark D. Hill for SunOS and Berkeley Standard Distribution (Unix), enables developers to test their cache ideas before writing them to silicon. The Dinero III is a trace-driven simulator (i.e., made up of a set of C and `awk` programs) with many options that make it ideal for testing hardware and software cache assumptions.

Practical Considerations

Dinero III may make life easier for developers, but it doesn't do anything for end users. The market is flooded with a bewildering variety of cache programs and hardware. That won't be changing anytime soon. There are simply too many variables in the caching equations for anyone to come up with a magic solution that will sweep away all other competitors from the marketplace.

For the most part, someone buying a cache won't know what mix of caching techniques have been selected. Cache designers guard their precious code creations as if they were the crown jewels. Some caches (e.g., Multisoft's Super PC-Kwik) give you command-line options so that you can turn on and off features such as full-track look-ahead buffering and posted-writes.

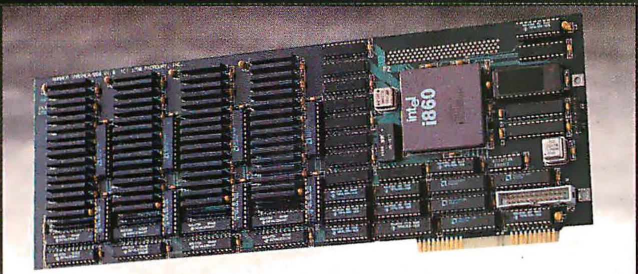
No matter what the formula is, all computers need caching. Secondary storage can never keep up with the CPU. Things aren't much better with primary-storage access speeds. In the race between memory latency and CPU speed, the CPUs continue to forge ahead. With the help of caches, our systems will try to keep up. ■

Steven J. Vaughan-Nichols is a full-time freelance writer and former programmer/analyst from Lanham, Maryland. You can contact him on BIX as "sjvn."

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STORAGE MANAGEMENT

Storage standards and automation are the keys to managing files and storage devices spread across a building or a continent

MIKE ROBINSON

As networks grow larger and more complex, the problems you encounter trying to manage data files, applications, and general archiving become more acute. The solution to these problems is automated storage management for distributed networks. Already available for supercomputers and mainframes, automated storage management systems are beginning to appear for networks of Unix machines and even, to some extent, for PC LANs.

Ideally, automated or intelligent network storage management embraces two key capabilities: transparent access to all files on the network and management of the hierarchy (or hierarchies) of mass-storage devices. *Transparent access* means that you can call up a file without knowing where it resides and the system will find it for you. *Hierarchical storage management* includes, but is not limited to, the following key capabilities:

- automatic migration of files from disk to tape or even optical storage, depending on frequency of use, disk space, and other parameters
- automatic backup and restoration
- automatic archiving

True open distributed computing calls for a distributed file system, not just with global file access but with transparent access as well. The Unix world gained fully transparent file access with the Andrew File System, and that capability will be made available to other operating systems, thanks to the Open Software Foundation. The OSF developed the Distributed Computing Environment (DCE) (see "Distributed Open Environments," November

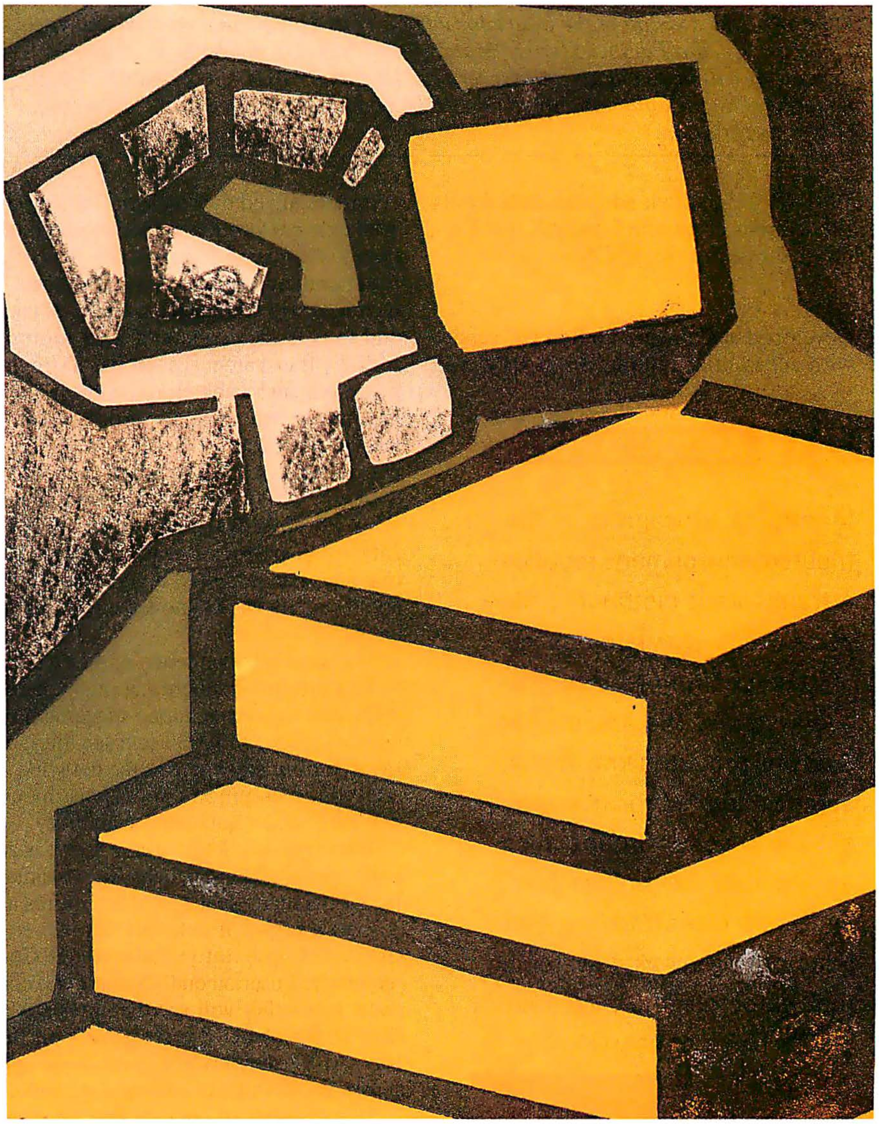


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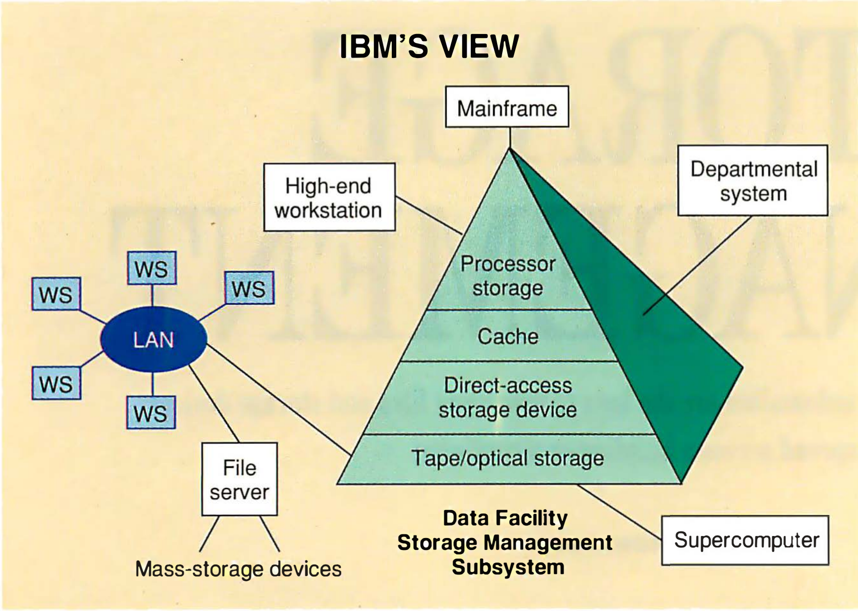


Figure 1: *IBM's vision of the future for what it calls system-managed storage is based on its Data Facility Storage Management Subsystem. The near-term extensions will be to clients and servers running under IBM's AIX and OS/2 and under SunOS, for uploading to an MVS/ESA computer for backup and archiving. (WS = workstation.)*

1991 BYTE), which adopted AFS for its file-system component called, the Distributed File Service (DFS).

AFS

Developed at Carnegie Mellon University with substantial funding from IBM and commercialized by Transarc (Pittsburgh), AFS delivers location independence, rather than just location transparency. Location independence means that a file can be moved at will without a change in its name and thus is the property that is required for fully transparent access. It is a stronger property than location transparency, which means only that an application cannot determine the location of a file from its name. In contrast to AFS, the de facto standard in the Unix world, Sun Microsystems' Network File System (NFS), offers only location transparency—that is, once a client machine has mounted a file system, the application does not know the physical location of the files.

Location independence requires a fully location-independent naming scheme. AFS uses a common name space within a network; thus, all AFS users see the same file tree from anywhere in the network. In addition, a common name space means that AFS offers unlimited scalability.

What's more, AFS's name space is actually global. (Transarc helps sites maintain the global name space, which requires access to a regional network. However, a site can choose not to participate.) Consequently, a user on one network who connects to another will see the latter's AFS files in his or her directory tree. In this way, AFS users have easy access to files across the country or around the world.

AFS consists of client/server elements and requires an Internet Protocol network. AFS servers handle volumes (i.e., collections of files and directories) that are not limited to a fixed amount of disk space. (Typically, each user is assigned a volume.) Volumes are connected at mount points, forming a single directory tree; therefore, not only do you have transparent access to all the files, but you have that access from any AFS machine on the network. A set of databases keeps track of all the volume locations and other system management information.

When you call a remote file, it is copied into local cache memory, directed by AFS's local (client) cache manager. The original version of AFS put the entire file into cache memory; AFS 3 moves 64-KB chunks into cache memory, thus reducing network traffic. AFS uses a callback scheme to ensure cache coherency. When you write to a file, the server notifies all the clients using the file that their cache memory is no longer valid and then updates the file. When a client issues the next read request, its cache manager gets the updated version from the server.

Among other changes, the OSF's DFS replaces the callback procedure with a token-passing scheme that includes several levels of access privileges, specified by each file's creator and assigned to potential users. More important, DFS will add protocol exporters, so that it can work with Unix, NFS, PC-NFS, and eventually, other file systems.

Standardizing Mass Storage

DCE and AFS provide part of the underlying pieces for automated network storage in a distributed environment. Other groundwork is being laid by the IEEE Technical Committee on Mass Storage Systems and Technology. The committee is well along in the development of the IEEE Mass Storage Reference Model (see "Enterprising Storage," September 1991 BYTE, page 218), which will form the basis for a set of standards for network-storage interchange. It is being developed by the committee's IEEE Storage Systems Standards Working Group. Industry members include Amdahl, Ampex, AT&T, Convex, Cray Research, Datatape, DEC, the Distributed Computing Solutions (Discos) Division of General Atomics, Epoch Systems, Hewlett-Packard, IBM, and Storage Technology.

The promise held out by projects such as the DCE—and its companion Distributed Management Environment—and by the standards that the IEEE seeks to develop are heterogeneous distributed networks, where you can call up files and data anywhere on a network without knowing the

BYTE ACTION SUMMARY

Managing storage in a distributed environment requires a transparent distributed file system and standards for automatic control of mass-storage systems. The Andrew File System provides the transparency needed for transparent file access. Groups such as the IEEE Technical Committee on Mass Storage Systems are developing systems that automate the migration and archiving of network files.

Managing National Assets

Responding to the information-storage and -retrieval needs emerging from advanced scientific research at government laboratories and universities, as well as from advances in high-performance networking, in which gigabytes and even terabytes of data are being or will be generated and shared, members of the computer industry have organized a collaborative research project to accelerate the development of technology for storage systems "that will be the future repositories for our national information assets," according to the draft paper describing the project. The industry participants are IBM's Federal Sector Division, Ampex Recording Systems, General Atomics' Distributed Computing Solutions Division, IBM's Storage Systems Products Division, Maximum Strategy, Network Systems, and Zitel. In addition, Lawrence Livermore National Laboratory will participate as the operational site and the applications supplier.

The industry members are funding their own participation. They are, however, seeking to affiliate the project, called Technology for National Asset Storage Systems, with the U.S. government's High-Performance Computing and Communications Initiative.

The project's goal is a unified storage system that is scalable to support mammoth quantities of data distributed nationally. The intention is to create a prototype and demonstration system that will represent a "significant advance in the technology for distributed storage systems capable of handling gigabyte-class files at gigabyte-per-second data rates." The system will support the widely accepted file access mechanisms (e.g., the Andrew File System [AFS]; the Network File System; the File Transfer Protocol; and the File Transfer, Access, and Management protocol).

Specifically, the participants expect the project to make major advances in hardware, software, and systems technology in the following areas:

- *network-attached high-performance storage*
- *multiple, dynamic, distributed storage hierarchies*
- *layered access to storage system services (i.e., to levels in the storage hierarchies)*
- *storage system management*

The project identifies many aspects in which a national asset-storage system must be unified. Beyond tying together multiple-storage sites and users across the country, such a system must be unified across data types and across user needs. It must span a range of file types from small text files to huge files of sensor-based data. It must also serve the diverse needs of users, from those who need highly abstract access to transparently managed files to users whose performance needs preclude abstraction and transparent access (e.g., different requirements for caching and migration).

All the members of the project are also members of the IEEE Storage Systems Standards Working Group, and the four areas of the project are being considered by the standards group. The group has asked for prototype implementations to test and verify the advanced concepts being discussed. The intention is that the prototype to be developed by the National Asset Storage System project will serve as such a prototype for the standards group.

The starting points for new software development will be General Atomics' UniTree hierarchical file and storage management system and Transarc's AFS distributed file system.

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location and the filenames, and where all mass-storage systems are managed automatically and invisibly. (The DME will address hierarchical storage management in the future.)

Making the automatic management of mass-storage systems possible requires information not only about filenames, their locations, and the access privileges but also about a file's contents. Such information is called *metadata*. Location and access information would be stored on the servers. This information already exists in AFS's databases. Metadata representing a file's contents would reside on client machines. The capability to create metadata is still a good way off.

Automatic Management

In managing storage, network administrators must be able to free up disk space on client machines and servers when necessary; place files on the least expensive storage medium that is appropriate, based on access requirements; ensure the safety of all data through adequate backup and archiving; and restore or retrieve files from backup or archival storage as needed. The automation of those and other management tasks is called *network storage management*, or sometimes *hierarchical storage management*. (As in most areas, the terminology is imprecise. Most people would argue that hierarchical storage management is a subset of network storage management, and, indeed, many people talk about managing multiple hierarchies. For these people, the storage hierarchy is not a concept but a specific storage organization with a specific type of medium or storage device at each level.)

Ideally, the network-storage management system would track all files according to a set of parameters that the network administrator specifies, and it would track an individual's files that you specify. It then would move the files from a local or file server disk to tape or optical storage. The two most common parameters are disk utilization (i.e., maximum and minimum) and the time of last access (when disk utilization reaches the maximum, a "least-recently used" algorithm is commonly employed; conversely, a file below the top of the hierarchy could move up). Such transfer of files from one level to another is called *file migration*.

The removal of inactive files to secondary storage is also known as *disk grooming*, especially in the PC world. However, some people call only the movement of a file down the hierarchy *migration*; movement up the hierarchy is then sometimes called *retrieval*, sometimes *caching*. In addition, the retrieval of a backup copy is called *restoration*.

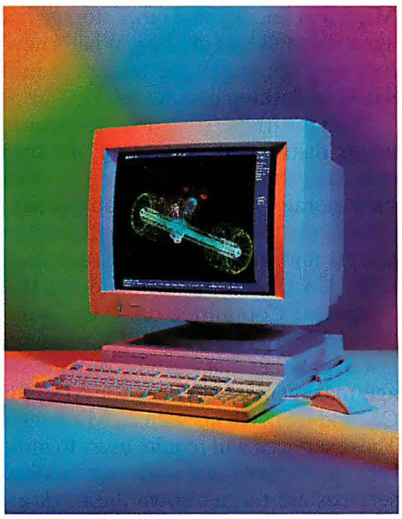
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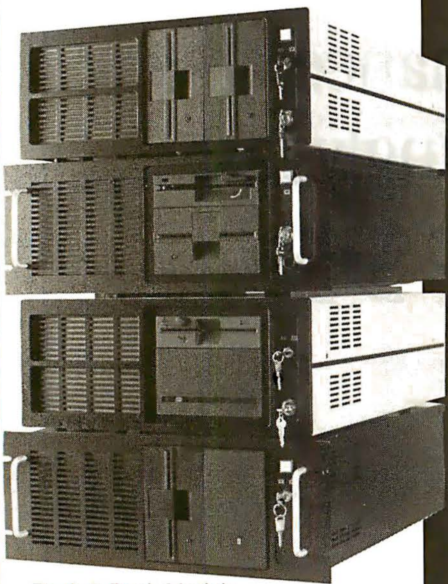
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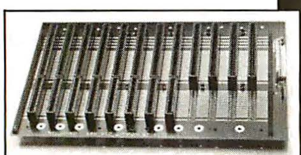
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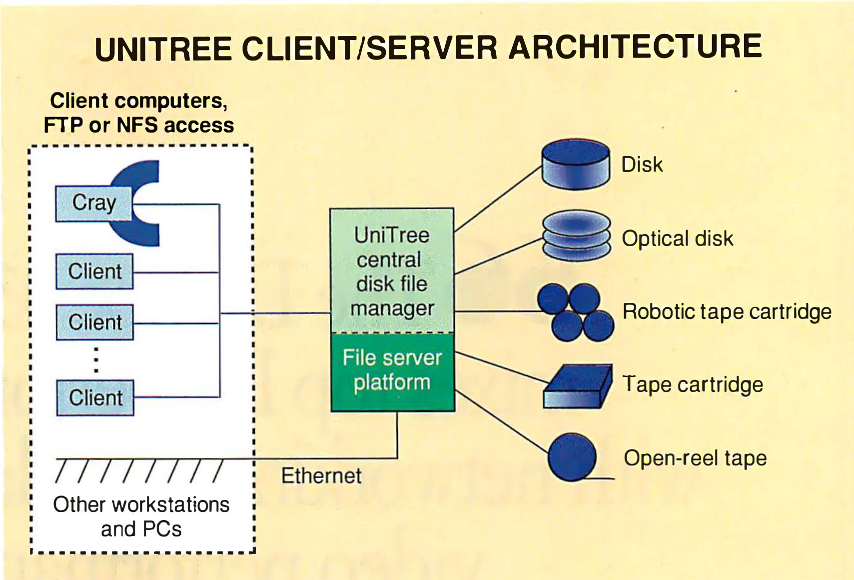


Figure 2: *UniTree from the Discos Division of General Atomics provides automatic and transparent file and storage management for Unix networks that use NFS or FTP access. Shown here in its simplest form, UniTree is being enhanced with software modules that run on client computers to form what the company calls a Virtual Disk System, whereby files are invisibly migrated from a client or server disk further down the storage hierarchy.*

Automatic file migration, backup and restoration, archiving, defragmentation, and tracking of files and other storage management activities are not new. They have existed for some time in the mainframe world. IBM, for instance, has the Data Facility Storage Management Subsystem for MVS (Multiple Virtual Storage) (see figure 1), and DEC has utilities supplying many of those capabilities for VMS. In addition, Cray Research offers the Data Migration Facility and other storage management tools and utilities. What's new is that they are beginning to appear in the world of desktop computers.

With the irreversible drive to heterogeneous distributed computing, the major computer makers are working to extend their storage management capabilities to smaller platforms, both through their own efforts and through groups such as the OSF, Unix International, and the IEEE Technical Committee on Mass Storage Systems and Technology. IBM announced last September that it would provide storage management services for AIX, SunOS, and OS/2 clients with an MVS server. These services will require users to initiate backup, recovery, and archiving; automatic services are further down the road, as is support for other platforms. Beyond those activities, IBM is taking part in a research project aimed at accelerating the development of technology for nationwide file systems with enormous amounts of data and multiple storage hierarchies (see the text box "Managing National Assets" on page 186).

For its part, HP's Information Architecture Group (Colorado Springs, CO) is defining a model for distributed information access and management. Called the Distributed Information Storage Architecture, it includes a component called StoragePlus that provides automatic physical storage management. Meanwhile, DEC's Architected Information Management group is working with customers to define and develop the Distributed Heterogeneous Storage Management architecture, which will serve as the basis for new storage management products. Existing products will start migrating to DHSM this year.

UniTree

A hierarchical file and storage management system, UniTree, is available for TCP/IP networks of Unix machines using NFS or the File Transfer Protocol (see figure 2). The core of UniTree was developed at Lawrence Livermore National Laboratory, originally as the file-serving component of a distributed operating system. The technology has been licensed by Discos (San Diego, CA), which is extending the capabilities in a joint development program with Livermore. Discos licenses UniTree to computer makers and system integrators. (It offers a similar system for

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VMS called Data Tree.)

The current UniTree software, the UniTree Central File Manager, runs on a server as a Unix application. For optimal use of storage media or for archiving, it migrates files to off-line storage, according to parameters set by the network administrator, and keeps track of the location of those files. When an off-line file is accessed, UniTree automatically restores it for immediate use. UniTree also provides continuous automated backup and restoration, making up to 16 copies (the administrator determines the number) and automatically recalls a file from backup when you access it, and the on-line version is not available.

Furthermore, when media or device errors occur, UniTree migrates the files residing on the failing disk or other device to alternative storage. UniTree lets you bring back deleted files through a "trash can" that retains deleted files for a period of time that you or the administrator specify.

Capable of operating any peripheral device that the file server vendor supports, UniTree can manage petabytes of data and millions of files. Indeed, there is no logical limit to the UniTree file system or to the number of files managed.

Alliant, Amdahl, Control Data, Cray Research, DEC, Fujitsu, and Sun Microsystems offer machines running UniTree. Within the last year or so, powerful file servers have been introduced for large heterogeneous networks by Aptec Systems, a maker of I/O computers, and Convex Computer and FPS Computing, two minisupercomputer makers, incorporating the software. As an example of UniTree's management capabilities, Convex's file server won a contract from Sandia National Laboratories to supply a mass-storage system that provides functionally transparent access to 100 gigabytes of disk data, 1 terabyte of archival storage, and automatic file migration.

Discos is readying a family of client-software modules that extend the capabilities and performance of the UniTree system. Users will have a varying degree of file access transparency, depending on the type and number of UniTree programs installed on their client machine. The main module, the UniTree Client Disk Manager, will add the client machine's drive to the centrally managed UniTree storage hierarchy, migrating local files to the server and retrieving them automatically and transparently. Discos calls the enhanced version the Virtual Disk System, and indeed, the ability to access, automatically and transparently, any file on the system is analogous to virtual memory.

Offering similar capabilities for Unix/NFS networks, but in a set of software and hardware products, is Epoch Systems (Westborough, MA). Epoch initially offered the Epoch-1 InfiniteStorage Servers, capable of storing 20 gigabytes to 1 terabyte in various configurations of magnetic disk and rewritable and write-once optical disks. The servers automatically migrate files among the three levels and perform automatic backup, disaster recovery, volume management, and archiving. Also, all storage remains on-line.

The Renaissance software expands those capabilities. Renaissance Migration centrally manages all network disk space on both workstations and servers. All directory and file-attribute information remains on the local disks so that the files appear to be local. Here, too, migrated files, including archival files, are automatically returned when accessed.

Help for PC LANs

Network storage management is no exception to the general migration of features and capabilities from larger computers and Unix workstations down into the PC arena. In fact, automation of storage management tasks is already available to some extent for PC LANs, especially NetWare. Cheyenne Software, Emerald Systems, Maynard Electronics, Palindrome, and Tecmar offer NetWare products that automate storage management. In addition, Mountain Network Solutions is developing similar capabilities, and Novell is writing migration application programming interfaces for its Storage Management Services architecture to help third-party developers create automated storage products for NetWare. Still, overburdened network administrators will have to wait some time before the high-end capabilities of mainframes, of Unix servers incorporating UniTree, or of Epoch's Renaissance will be available for PC LANs. ■

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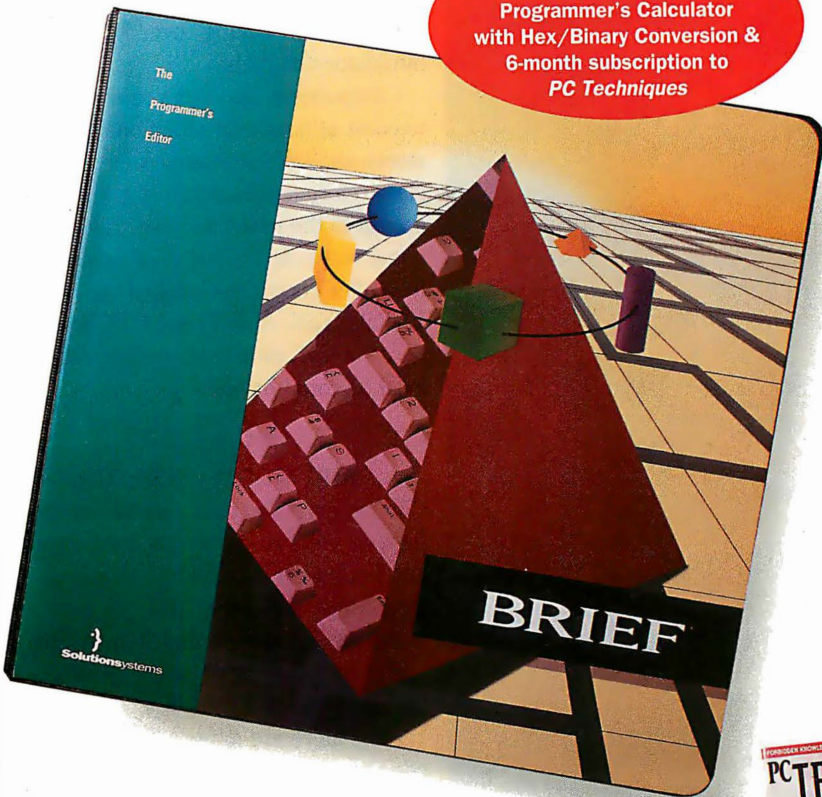
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ROD KIRK, TIM CHRISTIANSON, AND DANIAL FAIZULLABHOY

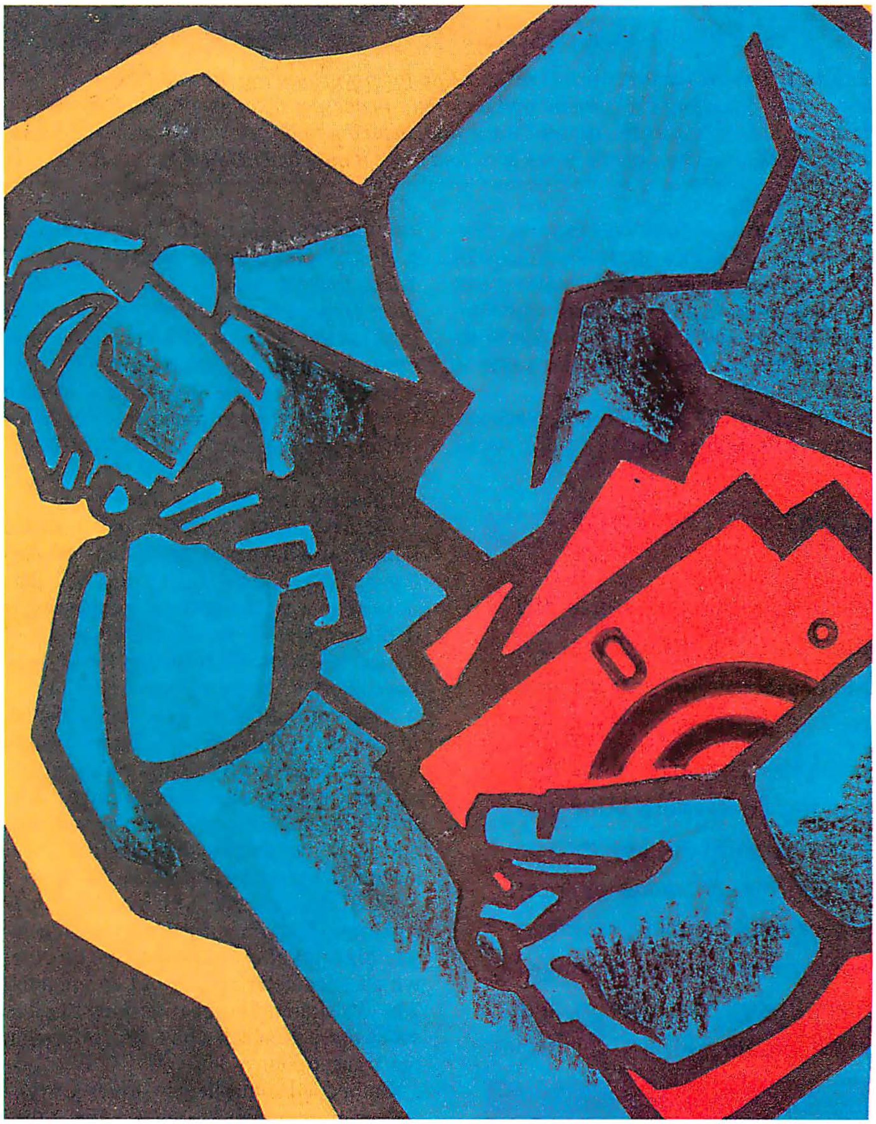
Increasing levels of intelligence and automation are now appearing in drives. Several factors are behind this trend, including demands for higher performance and more fully featured software in both operating systems and applications. For example, the size and complexity of Windows demands a lot more peripheral performance to run effectively than DOS does.

Network operating systems like Novell's NetWare and Banyan's Vines are also making new demands. Without high-speed peripherals, such systems encounter serious bottlenecks, particularly with multiple users on a file server. Older and slower peripherals cannot provide the performance needed.

Applications have moved along a similar growth path. With the 640-KB DOS boundary no longer a problem and DRAM prices moderate, applications commonly use many megabytes of disk space for programs and data. Increasingly sophisticated users expect to be able to read and write large amounts of data rapidly, not just to have a good execution speed. These expectations can't be met without high-capacity and high-bandwidth peripherals.

The need for enhanced capacity comes when drive form factors are shrinking, creating a need for vastly increased recording densities. This trend has led manufacturers of drives to use surface area more efficiently with techniques such as constant density recording (CDR) and embedding servo information on the disk.

CDR places more data on the outer tracks of a disk than on the inner ones, increasing the amount of data on a disk (see the text box "More Bits per Inch" on page 200). However, CDR also creates more



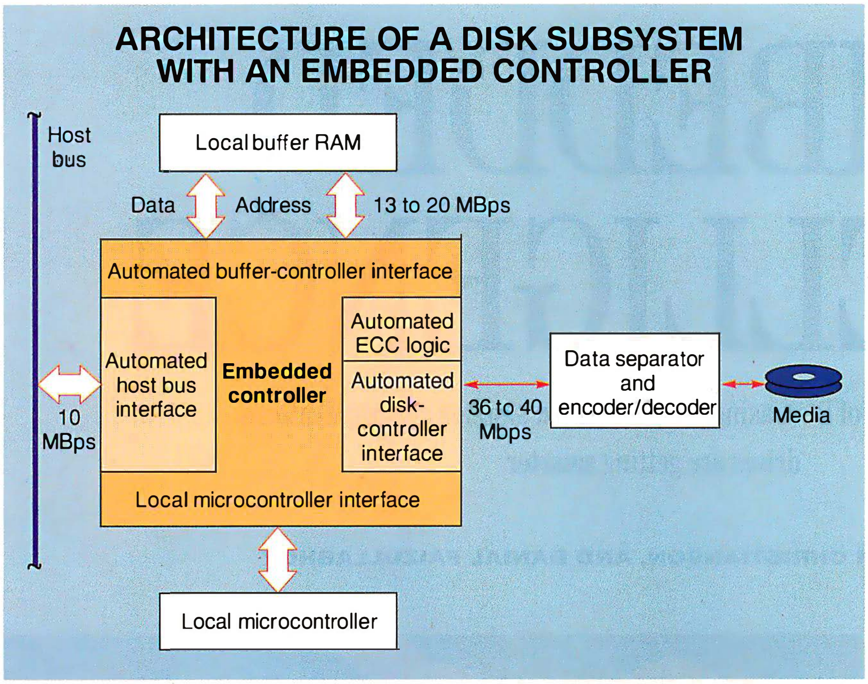


Figure 1: *The microcontroller is responsible for programming the embedded controller, handling exceptions, and, in single-processor designs, positioning the read/write heads over the desired track and ensuring that they stay aligned. The disk buffer holds data moving between host and disk; it may be DRAM or static RAM.*

work for the drive controller circuitry. Servo data keeps read/write heads aligned by feeding back alignment information from the disk to the head-positioning circuitry. These kinds of intelligent embedded controllers have added substantial value to drive control.

Increasing I/O bandwidth necessitates reducing the time required for a drive to locate the first data in the file requested as well as increasing the transfer rates between peripherals and system CPUs. To meet these requirements, you can buffer data on the peripheral, increase the media-to-buffer and buffer-to-host-CPU data transfer rates, reduce the overhead of each transfer, and support concurrent media-to-buffer and buffer-to-host-CPU transfers.

BYTE ACTION SUMMARY

As disk capacities increase and their physical sizes decrease, more automation and integration of functions in drives become critical requirements. Embedded controllers built into drives provide the key to continuing these trends by integrating error handling, interface automation, buffer management, energy conservation, and more into drives.

Exploring the Architecture

Hard drives contain platters that hold the data, read/write heads and associated analog circuitry, and digital circuitry. The digital circuitry typically contains an embedded-controller IC that is closely coupled to a microcontroller, buffer RAM, and host-interface circuitry (see figure 1).

The host-bus interface is either direct, as in the case of IDE drives, or made through a host adapter or a SCSI port on the motherboard, as in the case of SCSI drives. IDE drives connect directly to the system bus and place the functionality of a traditional system drive controller inside the drive.

SCSI is an interface for intelligent peripherals. It defines *initiators*, which issue high-level commands, and *targets*, which execute the SCSI I/O commands. The SCSI standard also defines the bus states through which a bus passes during a bus transaction.

Embedded controllers in drives are typically programmable-state machines that automate data transfer and interfacing functions under the direction of a microcontroller. Embedded-controller designs use internal registers and interrupts to communicate with the microcontroller.

Many embedded controllers execute microcode instructions that guide the embedded controller during a disk read or write. They contain disk sequencers, complete with a program counter, a stack, and branching logic to enable the use of microcode subroutines. These sequencers control track reading, writing, and formatting.

Microcode implementations typically support in-line instruction execution and branching to subroutines. The microcode program used with each drive contains a track format. Microcoded embedded controllers can typically transfer a full track of data without the microcontroller's intervention.

Anatomy of a Disk Track

Tracks are concentric circular areas of a disk that are broken into a series of sectors, each holding an identical amount of information. An index pulse, a special pattern written on a disk, determines the starting point of each track. It can also tell you when a specific sector on a track is missing (i.e., when the index pulse passes under the head twice without a match).

Each sector on a disk contains a series of fields (see figure 2). The ID header contains the variable frequency oscillator (VFO), which is used to lock the analog circuitry to the read/write frequency; the data-sync byte; the servo positioning information fields; and the cyclic redundancy check (CRC) fields.

The data-field byte sync specifies the starting point of data (as opposed to pad, servo, or VFO fields). The CDR field is used to embed servo information in a data field. The CRC field (shown as 16 bits) is for the ID header only. The CRC can detect errors, but it cannot correct them.

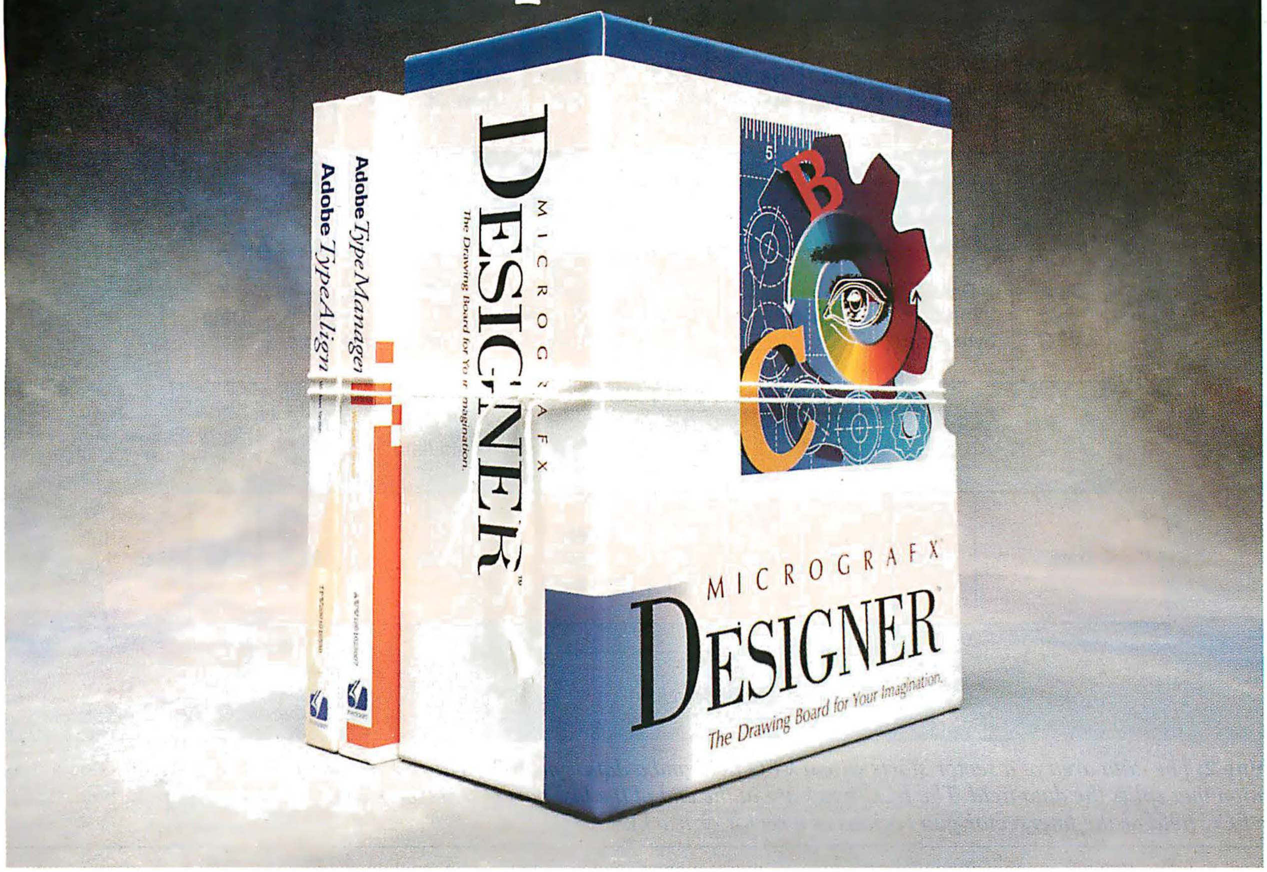
The data area of a sector also starts with a VFO field and a data-sync byte. In figure 2, servo information splits the data field. (Defects in the disk itself can also split a data field.)

The error-correction code bytes are at the end of a sector's data field; they are for the data area only and can both detect errors and correct them. You can also split the ECC field or the intersector-gap regions of a sector or track.

Handling the Splits

Embedded controllers use indications on the disk surface (e.g., an index pulse or a data-sync byte) to tell them to branch within the microcode program when reading

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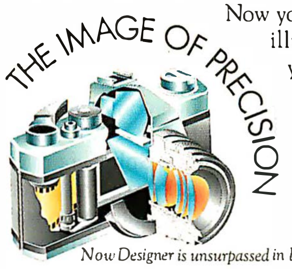
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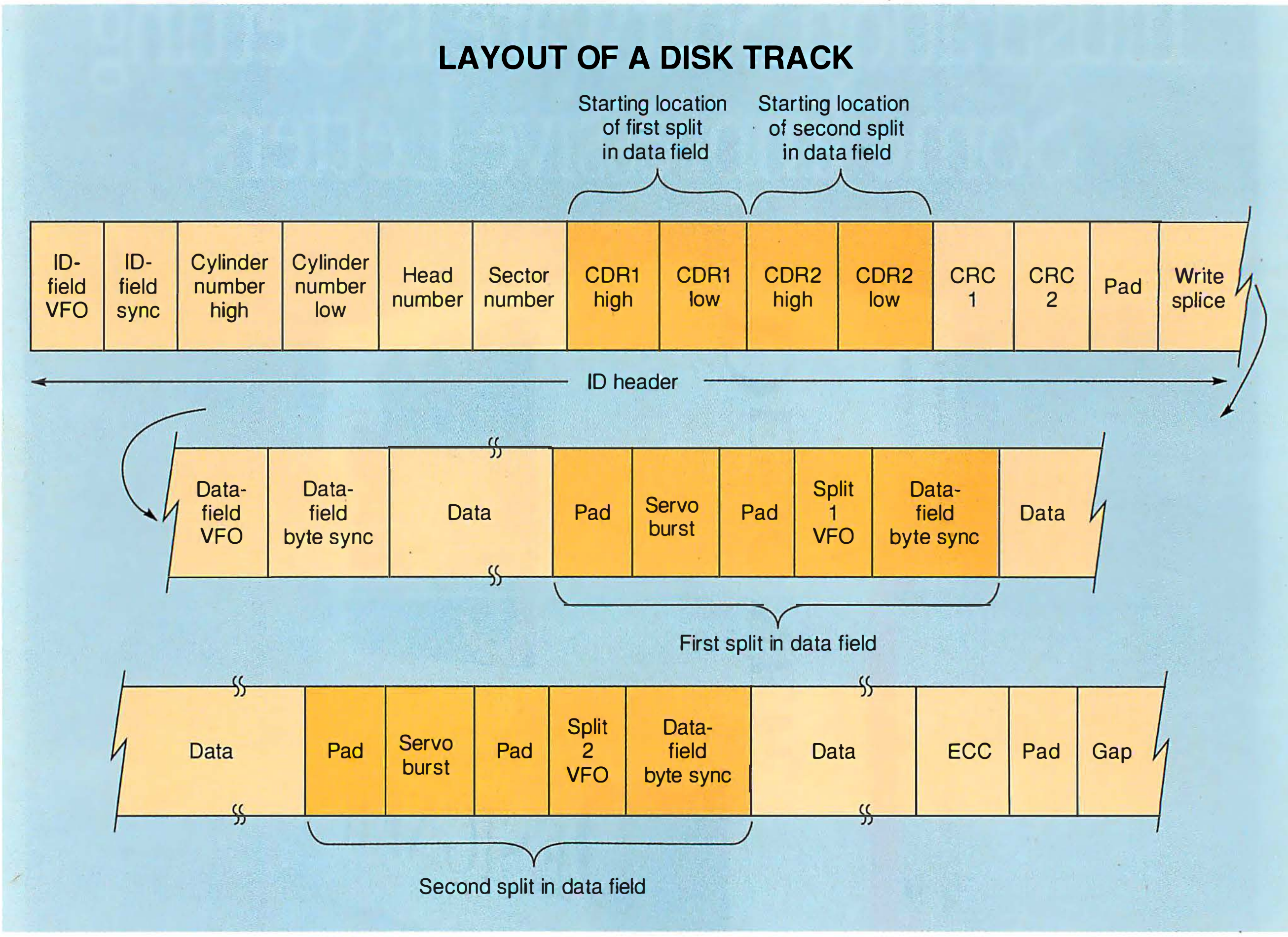


Figure 2: *The data area of a sector starts with a VFO field and a data-sync byte. The one depicted here is broken by servo information that splits the data field. The ECC bytes are at the end of the last part of a sector's data field (it's also possible to split the ECC field or the intersector gap regions of a sector or track).*

or writing sector data. This process occurs after the drive controller aligns the read/write heads over a disk track.

When servo or defect areas split the data area, the microcontroller must suspend ECC computation and buffer-data transfer and restart them with precise timing to maintain correct head positioning. Otherwise, the disk has to rotate another revolution to get the head back in position over the desired data. Clearly, you don't want to add more latency to the data access.

You can use several methods to signal the embedded controller to stop or start ECC computation and buffer-data transfer. These include the header-field, microcontroller-load, and freeze-ECC methods.

The header-field method codes the locations at which to suspend ECC computation and buffer-data transfer into the CDR fields. Each CDR field specifies the point at which servo data or defects commence.

Each value is typically loaded into a first-in/first-out stack in the embedded controller when the ID-header area is read. This FIFO stack feeds a *down counter* that is internal to the embedded controller and reduced by each byte transferred. An internal interrupt occurs when the counter reaches zero, and a branch to a predetermined address occurs in the microcode.

The microcode executed after the branch waits for the servo area to pass under the read/write head and looks for a VFO field and a data-sync field, which follow each split. The microcode executes a return, and ECC computation and buffer-data transfer begin where they left off. Thus, you don't need to specify the end point of the defect or servo areas.

The header-field method of implementing split fields is quite automatic. CDR values are loaded from the ID header into the FIFO stack. The microcontroller can dedicate its bandwidth to other tasks, so possibly a lower-performance, lower-cost microcontroller could provide the same data throughput. Although data splits can arbitrarily occur within a sector, the depth of the FIFO stack limits the number of splits possible.

Another method of handling split fields, microcontroller load, relies on the microcontroller to load the embedded controller's internal FIFO stack at the appropriate times. To ensure valid data, the microcontroller must never let the FIFO stack become empty during a sector read or write. This method is quite flexible. However, the microcontroller's bandwidth limits the number of splits possible, because it must also perform other tasks (e.g., read/write head positioning and alignment).

A third method of automating split-field implementations freezes ECC computation at a certain point. Splits are placed at fixed locations (usually with respect to the last data-sync field) within every sector's data area. The embedded controller counts the transferred bytes and branches to freeze ECC computation when the count reaches zero.

This method assumes that all splits occur in the same location in every sector;

More Bits per Inch

The quest for higher-storage capacity in smaller form-factor drives has led to significant advances in magnetic-recording technology. Not long ago, most hard drives used variable-density recording, in which data is written at a constant rate and the disk rotates at a constant angular velocity (see figure A). With this technique, the data on the inner tracks is denser than the data on the outer tracks. Thus, outer track space is used less efficiently.

An alternative method now gaining wide acceptance divides each disk into concentric zones. Recording densities in each zone are optimized and are nearly equal. Because outer zones are larger in diameter, they contain more bits. They also contain more sectors. Because the read/write head traverses more bits in the outer zones than in the inner zones in the same amount of time (the motor speed is constant), the data rate is higher in the outer zones. This method is called *constant-density recording* (see figure B).

Another technique being used to increase densities is the embedding of servo data on a disk. In the past, fine-head-positioning information, essential to the closed-loop servo systems necessary for medium- and high-capacity drives, was stored solely on a dedicated disk platter. Manufacturers are increasingly embedding this servo data within data fields in bursts 10 to 25 bytes in length.

As shown in figure B, servo bursts are commonly located along a radial path from the disk center, ensuring that head-positioning data occurs at consistent intervals. These splits must be ignored during the data transfer, error-detection, and error-correction processes; the embedded controller never sees the actual data within them.

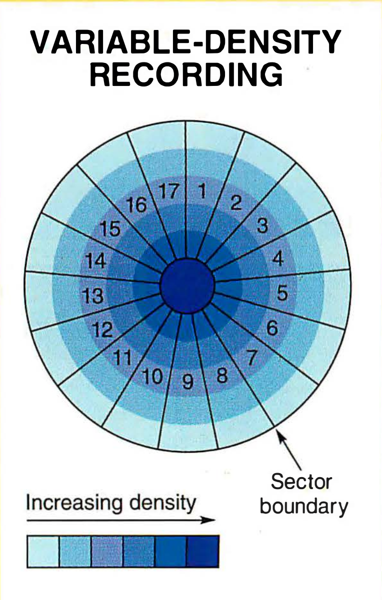


Figure A: *Typical hard disks have used variable-density recording, which writes data at a constant rate to a disk rotating at a constant angular velocity. Variable-density recording results in a lower density (and lower storage efficiency) for recorded data on the outer tracks of a disk.*

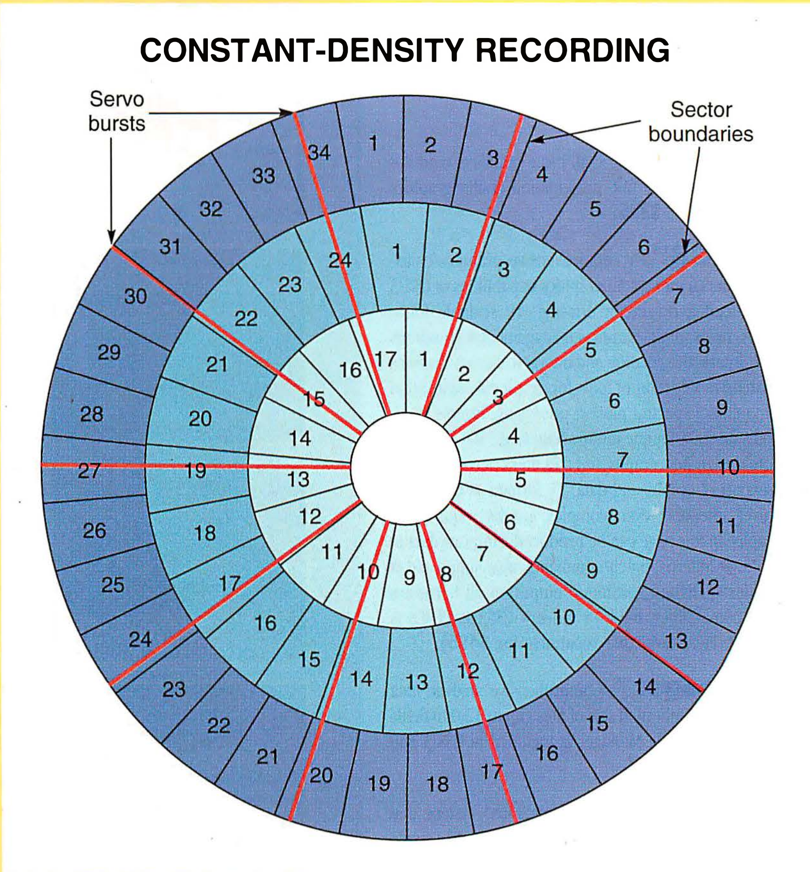


Figure B: *CDR is a more efficient storage method that is now gaining acceptance. It breaks each disk platter into concentric zones, each with a recording density optimized for it. Because the outer zones are larger in circumference, they can contain more bits. More sectors are recorded in the outer zones than in the inner zones (each sector contains the same number of data bits).*

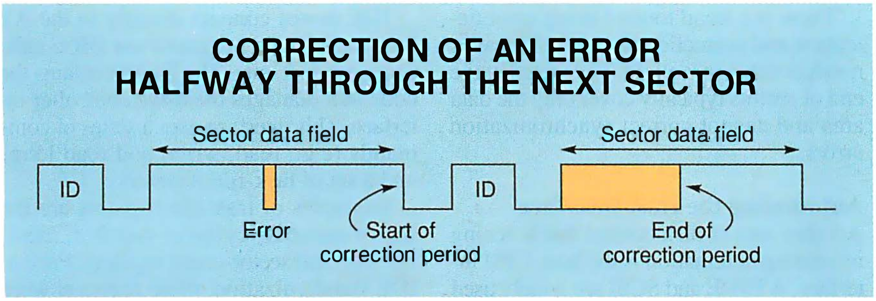


Figure 3: *Correctable single-burst errors are typically corrected by the time the disk has rotated halfway through the data sector that follows the sector with the error.*

if they don't, the microcontroller must dynamically modify the microcode program, using precious bandwidth. One potential shortcoming of this method is that the size of the counter in the embedded controller limits the number of bytes possible between servo (or defect) areas. However, this is typically not a problem, because the counter is at least 16 bits long.

Other methods for locating splits include issuing an external interrupt when encountering servo data (this requires additional external circuitry) or positioning the splits the same distance (in bytes) apart so that the down counter always contains an identical value. Ideally, this last method should use little or no microcontroller bandwidth, leaving the microcontroller free to concentrate on head positioning.

Embedded Error Handling

As track and bit densities increase, the probability of errors on disk surfaces also rises; in fact, defect densities grow exponentially with increases in track densities. High data transfer rates compound the problem, so detection and correction must be rapid and accurate.

The solution is to integrate error-detection and error-correction circuitry into an embedded controller. This architecture would allow error correction without microcontroller intervention.

Error detection and correction are too complex to occur at the full-disk data transfer rate. To automate this process, you must separate the detection and correction circuitry into two blocks.

Error-detection circuitry operates on the incoming data stream to determine if it contains errors. Error-correction circuitry operates simultaneously on previously transferred data. It typically fixes correctable single-burst errors by the time the disk has rotated halfway through the next sector (see figure 3).

The microcontroller can also correct errors off-line by executing a correction algorithm. You can correct more and longer error bursts this way. You can detect double-burst errors (up to 17 bits per burst with an 88-bit Reed-Solomon ECC) and correct them (up to 11 bits per burst) online. You are able to detect three bursts up to 11 bits each off-line and correct even larger error bursts off-line if you can tolerate a higher probability of misdetection

and miscorrection.

As more sophisticated circuitry is built into embedded controllers and longer ECCs are stored with each sector, larger and more frequent errors can be corrected. Certain types of disks (e.g., magneto-optical) require these more sophisticated methods of detection and correction. Higher error rates and more sophisticated error detection and correction also become necessary as bit densities increase on hard disks.

There is a trend toward using error detection and correction for track-format or nondata areas as well. ECCs located at the end of sectors typically cover only the data area and cannot correct synchronization errors.

Automating the Host Interface

Another area of disk control that is seeing increasing automation is the host-CPU interface. AT/IDE and SCSI are widely used interfaces.

IDE drives connect directly to the AT bus. Application programs use BIOS calls to access disk data. The BIOS contains the code that manages the drive controller interface. This interface uses a series of commands (e.g., read, write, and read long) and a set of task-file registers.

Examples of task-file registers are the sector-number, cylinder-number, head-number, and sector-count registers. Prior to IDE standardization, these registers were on a drive controller card; now they are typically internal to the embedded-controller IC in the drive.

Automating task-file-register updates during multisector reads or writes is becoming more commonplace in embedded controllers. Consider, for example, a multisector read of a series of contiguous sectors. With automatic task-file-register updates, the read process automatically updates the sector-number, head-number, and cylinder-number registers. The embedded controller contains the maximum value for each register. As each register wraps to 0, it can increment the next most significant one (e.g., the sector, head, or cylinder) in ascending order of significance.

Monitoring hardware signals on the AT bus as well as certain handshake bits (e.g., BSY or DRQ) used to interface to IDE drives is another area that more sophisticated embedded controllers are automating. These devices assert and deassert appropriate bits during data transfer and handshake sequences, speeding up the drive controller side of the transaction.

SCSI Automation

The SCSI-1 standard, adopted in 1986, defines the rules for asynchronous and synchronous data transfers. Both use REQ handshake signals (which the target asserts) followed by ACK handshake signals (which the initiator asserts) during transfers within the data phase.

Asynchronous transfers don't dictate how fast the initiator must assert ACK after receiving REQ; transfer rates are in the 2-MBps range. Synchronous transfers require the exchange of messages between the target and the initiator (prior to the first transfer) to establish the maximum transfer rate they can support (the highest allowable rate is 5 MBps).

The SCSI-2 standard, formalized in 1990, defines higher-speed synchronous transfers. Maximum transfer rates are 10 MBps (100-nanosecond cycle time) on a single cable and up to 40 MBps on a double cable. Sophisticated embedded controllers already handle 10-MBps transfers without microcontroller intervention.

The SCSI bus passes through a series

of phases while performing a data transfer. It starts with the bus-free phase and passes through the arbitration-, selection-, command-, data-, status-, and message-bus phases. Not all phases are required with all commands.

Earlier SCSI embedded controllers handled one phase at a time, interrupting the microcontroller when a bus phase was completed. This caused a time delay while the microcontroller programmed the embedded controller to handle the next bus phase.

Because the phases of a SCSI bus are so well defined, it's possible to automate control of multiple bus phases. These features are now appearing in embedded controllers and take the form of automated sequences consisting of multiple SCSI bus phases. Microcontroller intervention is still required, but not as frequently as with earlier devices.

The following are examples of multiphase sequences. One is the selection of a target via the selection phase, receipt of one or more message bytes, and receipt of a multibyte command in the command phase. Another is the transfer of data until the buffer is full or empty in the data phase and the transmission of the "save data pointers" and "disconnect" messages to the host. A third is the execution of the status, message, and SCSI-bus-free phases.

Note that the SCSI bus permits a target that needs time to retrieve data to disconnect from the bus, read the data, and reconnect to the bus to complete the desired transfer. Advanced embedded controllers are also automating the disconnect and reconnect operations by providing sequences of multiple SCSI bus phases that will execute without microcontroller intervention. The result is less latency between SCSI bus phases. Once again, the host adapter may well become the bottleneck.

Reconnecting the SCSI bus to a target that is ready to transfer previously requested data in a multiple initiator system has a unique set of constraints associated with it. Consider the case in which target 0 receives a command from initiator 1 for data that it must retrieve. Target 0 disconnects, retrieves the data, and tries to reconnect to initiator 1.

Prior to reconnection, the microcontroller on target 0 programs the embedded controller for reselection by initiator 1 and transfer of the requested data. If initiator 2, which has a higher priority than initiator 1, selects target 1, the programmed sequence on target 1 will not occur.

The result will be an interrupt from target 0's embedded controller to the microcontroller that is requesting assistance. Latency time occurs while the microcontroller determines the state of the SCSI bus. As future generations of embedded controllers contain more and more intelligence, they will be able to handle multitasking. This will negate the need for a multiple-initiator implementation to issue a microcontroller interrupt.

Managing Buffers

Buffer RAM is typically present in drive controller designs. The microcontroller uses it for scratchpad memory and off-line error correction. It also holds host-to-disk and disk-to-host data, as well as data that the embedded controller's internal ECC circuitry is correcting. If buffer RAM contains DRAM, refresh accesses also compete for its bandwidth.

The embedded controller typically is the arbiter for RAM accesses. Thus, it must contain a multiport access-control circuit. Many of today's embedded controllers do.

It's important not to lock out any type of access. For instance, refresh cycles must always be allowed. Host access during a disk-to-buffer-RAM transfer should also be permitted. Overlapping usage increases throughput substantially. One common way to prevent lock-out is to support *cycle stealing* (i.e., to allow the host-interface circuit to insert access cycles between adjacent disk-to-buffer-RAM cycles).

Concurrent access requires sufficient bandwidth. For instance, truly simultaneous disk-to-buffer-RAM and buffer-RAM-to-host transfers require the RAM-access bandwidth to be equal to the sum of the host and disk access rates. Embedded controllers now provide 15-MBps buffer access rates. This compares favorably with 40-Mbps serial data rates from the disk and 10 MBps across the SCSI bus. All these values will increase in the future.

Sufficient bandwidth for concurrent access is only part of the story. Because the host and disk interfaces use different clocks, synchronization is a concern. Using internal FIFO stacks at both interfaces ensures that embedded controllers won't limit either interface's performance.

Automating disk-to-host or host-to-disk transfers (i.e., reducing microcontroller accesses to RAM and embedded-controller registers) also boosts performance. You can accomplish this in several ways. One way is to incorporate buffer management logic in the embedded controller. This logic may support any of the following:

- buffer RAM that is segmented into buffers ranging from a single kilobyte to the maximum buffer size
- interface-specific counters that track the contents of each active buffer associated with the interface and that support circular buffers
- logic that suspends the transfer across an interface when its buffer becomes too empty or too full and that restarts the transfer when the buffer reaches a threshold level
- SCSI peripherals that are automatically disconnected when a buffer becomes too empty or too full and that are automatically reconnected when more buffer space is available

Energy Conservation

Finally, the growing sales of portable and notebook computers have increased the importance of conserving power and prolonging battery life. Reducing power consumption means turning off power-hungry circuitry (e.g., the high-current drivers used at bus interfaces) and reducing the frequency of clock signals—or just shutting them off (because CMOS technology is widely used in embedded-controller ICs, turning off clocks eliminates the power consumption of a particular block of logic). The challenge is to provide power-down modes while supporting automatic wake-up with minimal overhead.

Power-down implementations for drives rely on partitioning logic blocks so that essential circuitry can be kept in a power-on state, and on powering down nonessential circuits (e.g., the drive motor and read/write circuits) after a predetermined time-out period. For instance, if an embedded controller connected to a SCSI bus must wake up on selection, the associated logic must remain powered up.

Typical implementations generate an interrupt when the SCSI bus is selected, so the microcontroller will power up the appropriate devices and circuits. An equivalent AT/IDE implementation would power up when it received an AT disk-access command.

Microprocessors that incorporate on-chip power-down logic are now available for laptop and notebook computers. It is only a matter of time before the same type of capability appears in microcontrollers along with the many other functions already there. When incorporated into drives, especially future generations that include the embedded controller and microcontroller in a single device, on-chip power-down logic will open the window of performance even wider. ■

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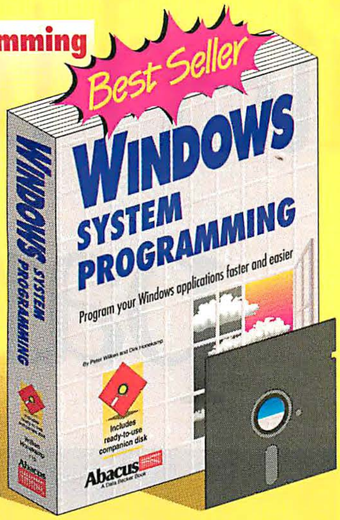
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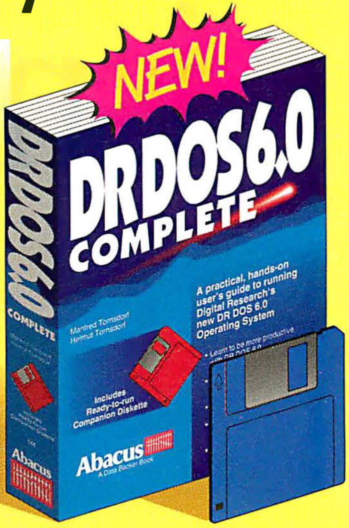
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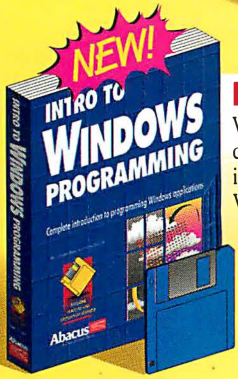
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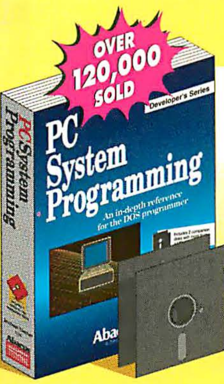
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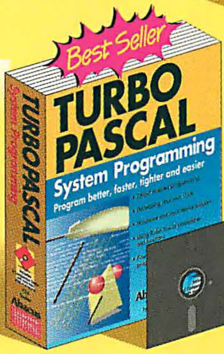


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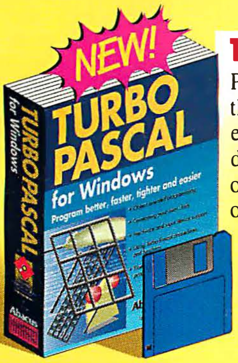
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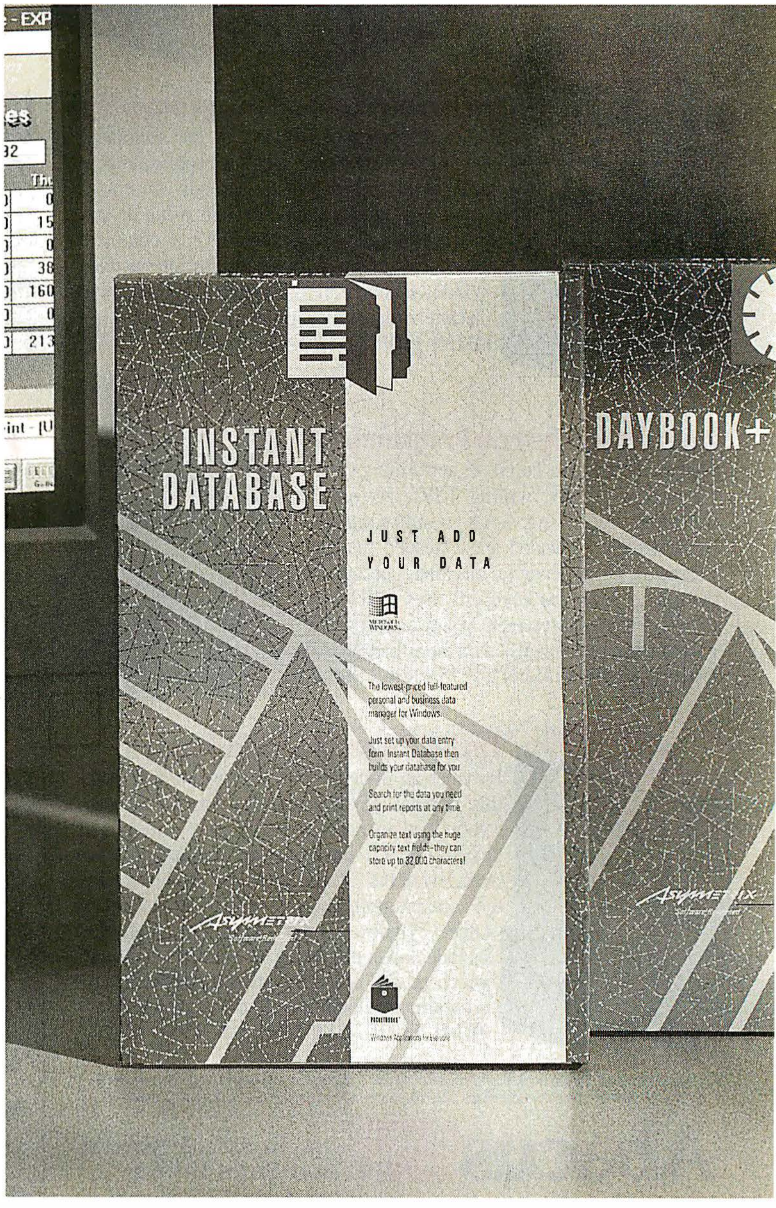
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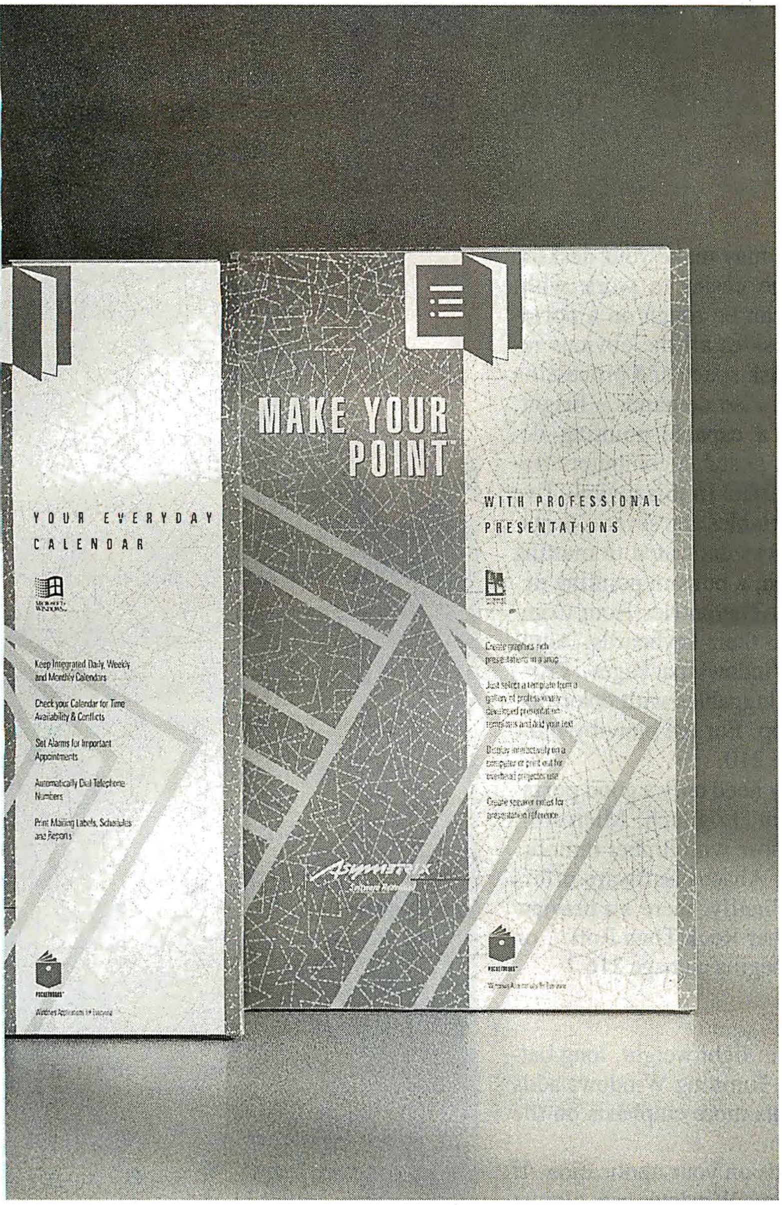
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WINDOWS ON THE ROAD



Nine portable computers and six portable pointing devices that let you go mobile with Windows

HOWARD EGLOWSTEIN

Windows may make your desktop machine easier to work with, but it can be rough on a portable. Besides all the obvious requirements for disk space and processing power, Windows also demands a bright, fast screen and a capable pointing device—two things portable computers traditionally don't offer. In this review, I've gathered nine portables and several portable pointing devices dedicated to making Windows more mobile. Each machine has a color screen, a built-in pointing device, or some other design enhancement for Windows. The entries from Commax, Everex, and Grid have pointing devices built into their keyboards. Aquiline, AT&T, and Texas Instruments offer portable Windows packages. From Dolch, NEC, and Toshiba, I've included AC-powered luggables with color displays so good you might consider replacing your desktop. For the blow-by-blow on each configuration, consult the features table on page 210.

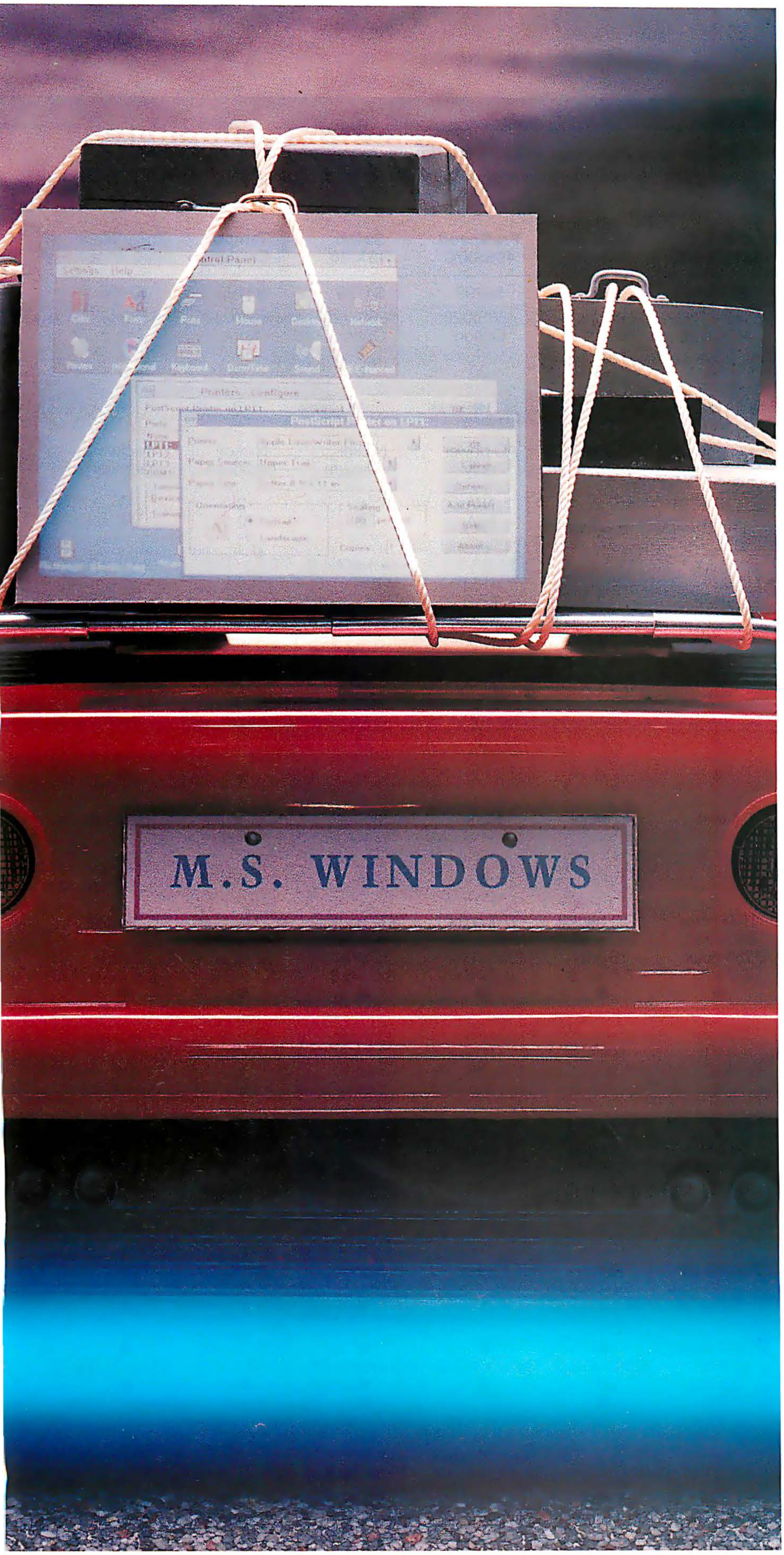
If you already have a fast notebook computer, you may need only a good portable pointing device to become Windows-ready. Appoint, Logitech, Microsoft, and MicroSpeed offer several flavors of trackballs for those with limber thumbs. Suncom's ICONtroller is a miniature, clip-on joystick. Abacus Software offers NoMouse, a software-only mouse-emulation package. Finally, there's a preview of a promising new pointing device in the text box "Rather Rock Than Roll?" on page 211. [Editor's note: Coverage of pointing devices begins on page 216.]

What Makes a Portable a Windows Portable?

Windows portables require all you'd ask of any portable: light weight, long battery life, a fast processor, and a comfortable keyboard. Running Windows adds the pointer requirement, demands a hard drive, and puts more emphasis on the quality of the screen.

The weight you assign to each of these factors depends on your application. If you're looking for a general-purpose machine for part-time Windows use, almost any notebook will suffice. The coming generation of machines based on Intel's

PHOTOGRAPHY: MEL LINDSTROM © 1992



BYTE ACTION SUMMARY

- **WHAT WINDOWS-CAPABLE PORTABLES AND POINTING DEVICES DO**
  These portables are ideal for running Windows; each features a pointing device and a color screen or another Windows optimization. Portable pointing devices are designed to tag along with these systems, giving you mouse capability without requiring desk space.

- **LIKES**
  New portable technologies make it possible to use Windows while traveling. Better screens and pointing devices and lighter and more capable systems mean that you can tote Windows applications almost anywhere.

- **DISLIKES**
  Many pointing devices are difficult to master; some verge on the unusable.

- **RECOMMENDATIONS**
  Although the GridCase 1550SX is well laid out and has an outstanding pointing device, the system is just too heavy for real traveling. For all-around ease of handling and good Windows operation, Everex's Tempo Carrier is the best choice.

386SL chip, represented by Zenith's Mastersport 386SL (see "Notebook Power Management at Its Zenith," December 1991 BYTE) and here by Aquiline's Arima SN386SL, will make good choices.

Full-time Windows en route makes small size and long battery life critical. It's also convenient to have the pointing device built into the keyboard so you don't have to wrestle with clamps and cables.

If you'll use Windows only when you arrive at your destination, size isn't so important, and you may not need a battery at all. Dropping the requirement for complete portability can get you a color screen or a very fast processor, in a machine like NEC's ProSpeed 486SX/C.

You might also consider an alternative to carrying Windows with you: controlling Windows applications remotely by modem. A review of some software that makes this possible appears in the text box "Windows by Phone" on page 214.

I have evaluated Windows portables

FEATURES OF PORTABLE COMPUTERS FOR WINDOWS

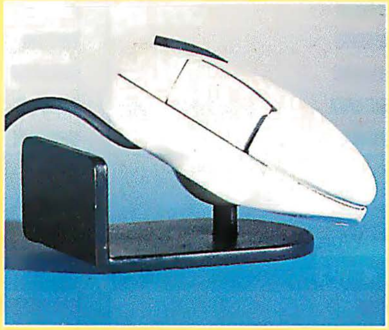
These are the portables that run Windows best. The most important features for Windows operation are a good screen and a comfortable pointing device, but the usual portable considerations of battery life, size, and weight will color your choice of favorite. (● = yes; ○ = no.)

	Arima SN386SL	C-P.A.C. 386SX-20C	GridCase 1550SX	ProSpeed 486SX/C	Safari NSX/20	Tempo Carrier	TravelMate 3000 WinSX
Price (as tested)	$2695	$11,040	$3905	$9299	$4199	$3195	$3199
Processor/speed (MHz)	386SL/25	386SX/20	386SX/20	486SX/20	386SX/20	386SX/20	386SX/20
Math coprocessor	None	387SX/20	387SX/20	Option	Option	None	None
Memory as tested (MB)	2	4	2	4	2	2	4
Memory (maximum; MB)	10	16	8	20	6	8	6
Memory upgrades user-installable?	●	●	○	●	●	○	●
Battery							
Technology	Nickel-cadmium	AC power only	Nickel-cadmium	AC power only	Nickel-cadmium	Nickel-cadmium	Nickel-cadmium
Battery life (manufacturer's claim; hours)	5	N/A	2	N/A	6	2	3
Battery recharge time (hours)	2	N/A	2	N/A	6	2	4
System unit							
Dimensions (W x H x L; inches)	11 x 8.5 x 1.7	16 x 9.5 x 7.8	11.5 x 2.5 x 15.0	14.8 x 4.2 x 15.6	12 x 1.8 x 9.5	8.5 x 6.75 x 11	11 x 1.8 x 8.5
Weight with battery (lb.)	6.0	18.0	13.7	17.0	7.3	5.2	5.7
External power supply							
Dimensions (W x H x L; inches)	5.5 x 3 x 1.4	N/A	N/A	N/A	5 x 1.5 x 2.5	2.5 x 1.75 x 5.87	3.25 x 1.75 x 5.5
Weight (lb.)	0.9	N/A	N/A	N/A	0.8	1.3	1.0
Keyboard							
Number of keys	81	86	77	91	82	80	79
Detachable?	○	●	○	○	○	○	○
Key travel (mm)	2.8	3.5	3.5	3.5	3.5	2.5	3.0
External keyboard port?	○	●	●	○	●	●	●
Pointing device							
Type	Trackball	None	Isopoint	None	Mouse	KeyMouse J Key	Trackball
Mouse							
PS/2 mouse port?	○	○	○	●	●	●	●
Display							
LCD type	CCFT[1] backlit	TFT[2] color	LCD backlit	TFT color	TST[3] backlit	LCD backlit	TST sidelit
Resolution	640 x 480	640 x 480	640 x 480	640 x 480	640 x 480	640 x 480	640 x 480
Gray levels/colors	64 gray	256 color	16 gray	256 color	32 gray	32 gray	32 gray
Screen area (W x H)	7.6 x 5.8	6.2 x 8.7	8.5 x 5.8	8.4 x 6.0	8.0 x 6.0	5.1 x 6.8	8.0 x 6.0
External video port?	●	●	●	●	●	●	●
Hard drive							
Manufacturer	Conner	Conner	Conner	Conner	Conner	IBM	Conner
Size (MB)	40	120	60/120	120	40	80	60
Interface	IDE	IDE	IDE	IDE	IDE	IDE	IDE
Access time (ms)	19	19	19	19	19	19	19
Internal floppy drive							
Size/capacity	3½-inch/ 1.44-MB	3½-inch/ 1.44-MB	3½-inch/ 1.44-MB	3½-inch/ 1.44-MB	3½-inch/ 1.44-MB	3½-inch/ 1.44-MB	3½-inch/ 1.44-MB
Communications							
Internal modem	2400 bps	N/A	2400 bps	Option	2400 bps	2400 bps	Option
Serial ports	1	2	2	1	1	2	1
Parallel ports	1	1	1	1	1	1	1
Expansion options							
Standard slots	None	Five 16-bit	None	1 EISA	None	None	None
Proprietary slots	None	None	1	1	1	1	1
Bundled software							
Setup utilities	None	ROM-based	●	●	●	ROM-based	●
DOS	MS-DOS 4.01	Option	MS-DOS 5.0	MS-DOS 5.0	MS-DOS 4.01	MS-DOS 4.01	MS-DOS 5.0
Windows	●	Option	●	●	●	●	●
Cursor enhancement	EZ-Cursor	None	●	○	●	None	Change Cursor
Other	InSync	QA Plus	○	PFS:WindowWorks, Magic Cursor	AT&T Access Plus, Microsoft Prod. Pack	Diagnostics	○
Warranty	3 months	1 year	1 year	1 year	1 year	1 year	1 year

[1] Cold-cathode fluorescent transistor. [2] Thin-film transistor. [3] Triple supertwist.

T3200SXC	UltraThin Plus
$8476	$3995
386SX/20	386SX/20
None	None
5	4
13	4
●	○
AC power only	Nickel-cadmium
N/A	2
N/A	4
14.6 x 4.3 x 15.6	8.5 x 1.4 x 11
17.0	4.5
N/A	3 x 1.6 x 5.8
N/A	1.0
91	79
○	○
3.5	2.5
●	●
None	Membrane/ touchpad
●	●
TFT color	TST backlit
640 x 480	640 x 480
256 color	32 gray
8.3 x 6.2	6.8 x 5.1
●	●
Conner	Conner
120	80
IDE	IDE
19	19
3½-inch/ 1.44-MB	External 1.44-MB
2400 bps	2400 bps
2	1
1	1
1 8-bit, 1 16-bit	None
N/A	1
●	●
MS-DOS 4.01	DR DOS 5.0/6.0
○	○
None	○
○	○
1 year	1 year

Rather Rock Than Roll?



If you'd rather rock than roll, take a look at Zirco's PalmPoint, a portable pointing device with a design all its own. The PalmPoint was nearing production as I assembled this review. The design is good enough that production versions should be warmly received by those unsatisfied with current pointing-device technology.

The PalmPoint is a gadget that you control by tilting. You mount the base to the side of your keyboard and steer the cursor around by tipping the entire unit from side to side. The unit pivots on a ball attached to the stationary base. Rotating the unit moves the mouse cursor around on the screen—it feels a lot like adjusting a car's side mirror.

I found the PalmPoint as easy to use as a real mouse, and of course it requires very little table space. If I had one complaint, it is that the ballistic action of the PalmPoint was a little hard to get used to; I sometimes ran out of rotation space on the unit with the cursor still stranded in the middle of the screen. Still, the PalmPoint is comfortable and natural, and it should give the clip-on trackball group of portable pointers a real run for the money. For more information, contact Zirco, Inc., 10900 West 44th Ave., Wheat Ridge, CO 80033, (303) 421-2013.

quantitatively for speed and battery life. Notes on the tests appear in the text box "Measuring Speed and Endurance" on page 218, and the results are graphed in figures 1 and 2. However, my primary gauge of the quality of each machine is simply the experience of using it from day to day. I've run Windows on every one and used each in and out of the office.

Arima SN386SL with Thumbelina

The $2695 Arima from Aquiline has the distinction of being the only 386SL machine in this review. The 386SL-based machines have an advantage over 386SX machines in a Windows environment, thanks to the advanced power management capability of the processor. SL technology makes it easier for manufacturers to shut down vital parts of the computer during idle periods. Only 386SL designs can sleep even in enhanced-mode Windows without special hardware hacks. In BYTE's battery-life tests, the Arima was a top performer, surviving for 4 hours and 15 minutes.

The Arima comes with DOS and Windows installed and includes an Appoint Thumbelina (see page 220). Folding access doors cover serial, parallel, and expansion ports for other options. Although the machine performed well, the construction showed a lack of attention to detail. Also, it's hard to type on the stiff, short-travel keyboard.

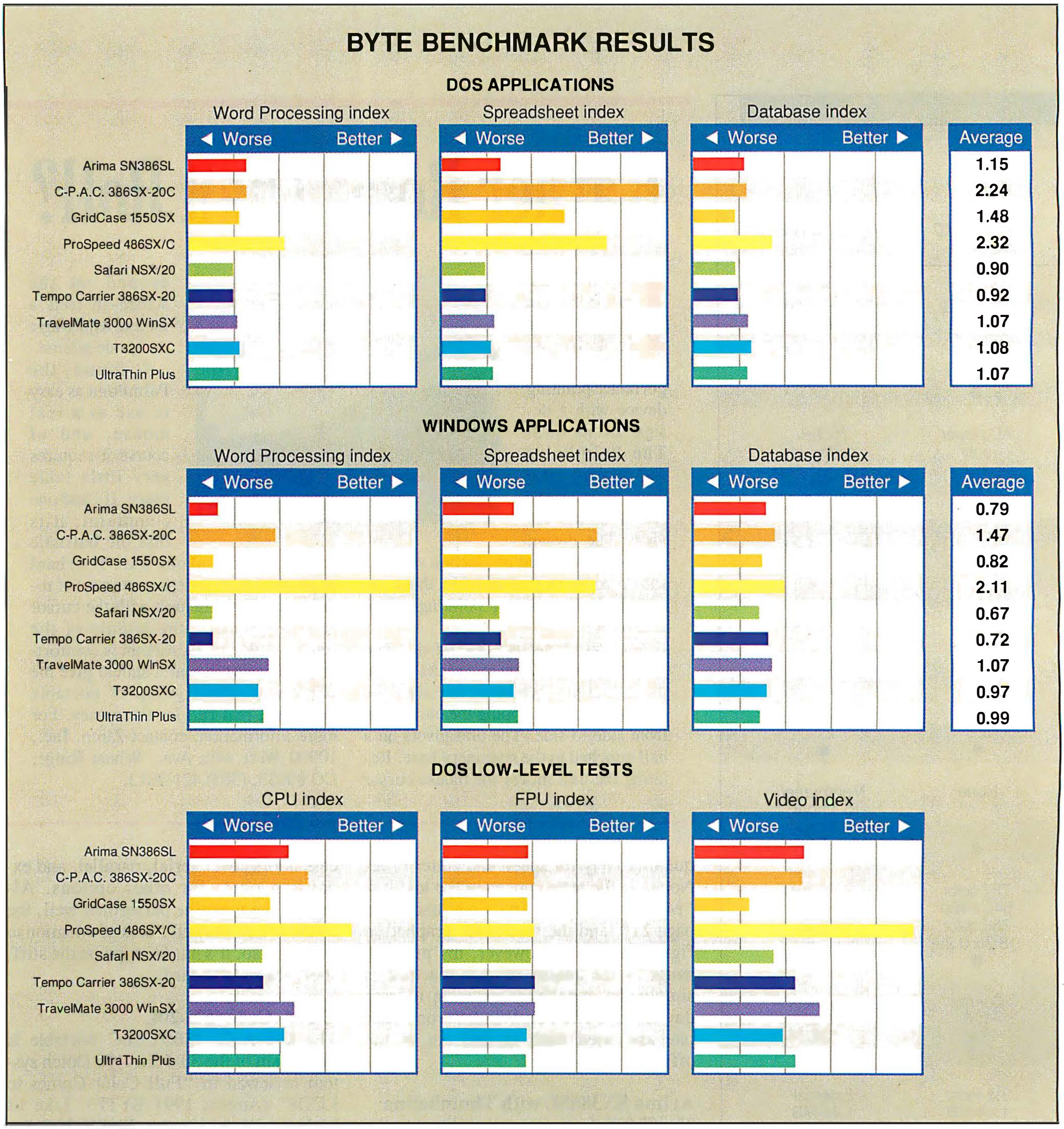
C-P.A.C. 386SX-20C

The C-P.A.C. 386SX-20C portable is the cousin of the 33-MHz 486 Dolch system reviewed in "Full Color Comes to LCDs" (August 1991 BYTE). Like its high-powered kin, the 386SX-20C has a 256-color Sharp thin-film-transistor (TFT) LCD panel.

This box gives you a 3½-inch 120-MB IDE hard drive, five ISA expansion slots, and a full-size keyboard for $11,040. Although it looks portable, it carries like a suitcase—18 pounds is a lot of computer to drag around. However, once you get where you're going, it's like having a full-featured desktop.

The color screen is excellent, and the keyboard is a joy. Benchmark performance was outstanding even considering the C-P.A.C.'s 387SX FPU advantage. This system blasted the other 386SX/20s even on our CPU benchmarks, where floating-point speed does not play a part.

continued



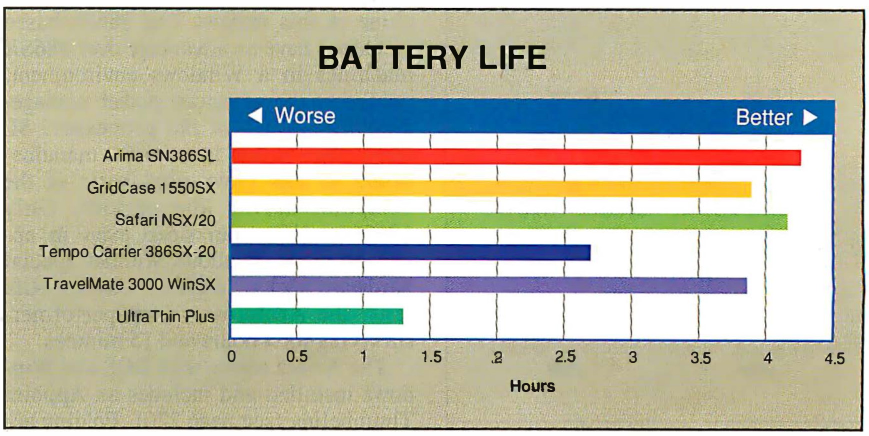


Figure 1: *The high-speed NEC ProSpeed 486SX/C proved the fastest portable, as you'd expect. However, there were unexpected performance variations among the 386SX/20 designs, from the top-performing Dolch C-P.A.C. 386SX-20C (which included a math coprocessor) to the surprisingly sluggish AT&T Safari NSX/20 portable.*

Figure 2: *The dual-battery Safari NSX/20 made up for lackluster speed with outstanding battery life; it was bested only by the Aquiline Arima SN386SL notebook.*

GridCase 1550SX with Isopoint

The GridCase is one of the few remaining battery-operated portables that don't qualify as notebooks. Yes, it's very big and heavy, and compared to a notebook machine, it feels like a concrete block. However, if you worry about operating a typical notebook in a harsh environment, Grid Systems' $3905 GridCase will put you at ease.

The GridCase turned in a very respectable 3.9 hours on the battery-life test—in good company behind the Safari NSX/20 with its dual batteries and the Arima with its 386SL.

The distinguishing feature of the GridCase is its built-in Isopoint pointing device. It's mounted in front of the space bar, right where your thumb goes. To move the mouse cursor left and right, you slide the Isopoint bar to either side. To move up and down, you roll the bar as you might roll a pencil on a desk. Pressing the bar with your thumb clicks the mouse. The Isopoint emulates a Microsoft bus mouse, and it works wonderfully well with Windows.



Photo 1: *The Everex Tempo Carrier (right) and the Toshiba T3200SXC are both excellent machines for running Windows. The Tempo has a KeyMouse built into its keyboard for cursor control and ships with a standard mouse as well. The T3200SXC has the best color display of any portable we have seen.*

ProSpeed 486SX/C

NEC's brand-new ProSpeed 486SX/C portable smashed the competition in our performance tests, thanks to its 20-MHz 486SX processor. Like the Dolch and Toshiba portables, the ProSpeed has a 256-color TFT display. Even with the high-powered processor, the $9299 ProSpeed still costs less than the C-P.A.C. 386SX/20C.

The ProSpeed's one EISA and one proprietary expansion slot make it less versatile than the C-P.A.C., but one standard slot will be enough for most folks. Windows is refreshingly responsive with the ProSpeed's fast processor and fast hard drive. If you need a color system for high-powered Windows applications, give the ProSpeed a long look.

Safari NSX/20

I liked the AT&T Safari NSX/20 as a general-purpose 386SX notebook, but it's quite expensive at $4199. The machine has a high-quality feel, and it runs a long time (4.1 hours) on a single charge of its dual batteries. It ships with a nicely styled AT&T mouse.

The Safari NSX/20 disappointed me on performance tests. It ranked last in almost all the application tests—a showing likely related to its poor score in the low-level CPU tests.

What does the Safari bring to the Windows party? Besides the mouse and its preinstalled Windows, the machine's documentation is provided in electronic format as a Toolbook application. If you have any questions on machine operation, bring up Windows and click on the topic you need help with. I found on-line documentation a curious idea—if you're having trouble getting the machine to boot, on-disk documentation won't help.

Tempo Carrier with KeyMouse

Weighing in at just 5⅕ pounds, the Everex Tempo Carrier (see photo 1) was a pleasure to travel with. In this small package you get 2 MB of RAM, a hard drive, a floppy drive, and a built-in pointing device for $3195.

The Everex KeyMouse piggybacks on the *J*, *F*, and *D* keys of the keyboard. All the keyboard keys auto-repeat except the *J*. When you hold down the *J* key, it turns into a mouse controller. Pushing the key gently in any direction moves the cursor. The *F* key becomes the primary mouse button.

I found KeyMouse extremely handy for Windows word processing. With your fingers in touch-typing position, you can type as usual. If you want to move the cursor, you hold your right index finger on the keyboard, move the cursor, and click with your left index finger. The movement takes some practice. Other BYTE editors tried it and never quite got the hang of it. Everex supplies a regular mouse with the Tempo for people who can't deal with the KeyMouse or who want a mouse when they're not in an airplane seat.

Battery life was the Tempo's only real drawback. My working style doesn't often demand that I spend long hours running on battery power, so I could overlook the short 2.7-hour running time.

TravelMate 3000 WinSX with TravelPoint

Texas Instruments' (TI) $3199 TravelMate 3000 WinSX is a TravelMate with modifications for running Windows. The power management hardware and software have special provisions for handling background tasks during shutdown periods and for keeping the time-of-day clock accurate.

The TravelMate 3000 WinSX also has a few touches that make presentations easier. If you're running on an external display (e.g., an LCD overhead projection panel) and you leave the machine idle, it shuts down but leaves the video output frozen with its last image. You can bring the machine alive again by pressing a button on the TravelPoint pointing device. Combining these two features

Windows by Phone

Steve Apiki

If you're committed to Windows and you need to compute while traveling, you'll learn to live with some limitations. But while you may be able to adjust to a clip-on trackball, your applications and data files may prove less adaptable. Resource-hungry applications and, especially, centralized data need to remain in your office while you're on the road. How do you keep in touch?

The four Windows remote-control packages presented here offer solutions. Each controls a Windows session running on a machine to which you're connected by modem. In effect, they bring the Windows environment to you via a phone connection. You take over the host computer, watching its screen and controlling it with your mouse and keyboard.

Because these products must operate over asynchronous lines, they have to perform within a very restricted bandwidth. And because there is so much information present in the screens of Windows (or other GUIs) compared to text interfaces, Windows remote control over phone lines is a difficult problem.

The New Crew

These four packages represent the next generation in Windows remote control. They fall into two categories: the classic remote-control design that ships bit maps scanned from video memory from host to remote unit (Norton-Lambert's Close-Up) and those designed to intercept Windows display calls and redirect messages across the wire (Microcom's Carbon Copy for Windows, Triton Technologies' Co/Session, and Ocean Isle's Reachout). Each design is an attempt to bring reasonable performance to Windows run by phone. The packages offer the features and utilities outlined in the table. All represent significant improvement over what was available only last year.

Close-Up 4.0 is the only screen-memory scanning package represented. Central Point Commute also belongs in this category, but the timing of this article meant that I could have tested only version 1.1, which Central Point plans to make obsolete by the time you read this.

Close-Up works by transmitting screen bit maps from the host to the remote unit. By heavily compressing the data, Close-Up wrings every bit of performance from the connection. In Windows, Close-Up fares best when you need to transmit bit maps or where the number of Windows graphics calls rivals the amount of data required to send bit-map updates (e.g., editing in a drawing application). Also, Close-Up's direct scan of video memory guarantees

FEATURES OF WINDOWS REMOTE-CONTROL SOFTWARE

Remote-control packages vary in their support for DOS and Windows and the sophistication of their utilities. (● = yes; ○ = no; N/A = not applicable.)

	Carbon Copy for Windows 1.0	Close-Up 4.0	Co/Session 6.0	Reachout 2.0
Price				
Two-PC package	$199	$199	$195	$179
Windows support				
Real mode	○	●	●	●
Standard mode	●	●	●	●
Enhanced mode	●	●	●	●
Full-screen DOS session	○	●	●	●
Windowed DOS session	●	●	●	●
DOS remote to Windows host	○	●	●	●
Graphics modes	Super VGA, VGA, EGA, CGA, Hercules	VGA, EGA, CGA	VGA	Super VGA, VGA, EGA
DOS support				
Memory required (host/remote)	N/A	34 KB (host)[1]	262 KB/126.2 KB[2]	146.7 KB (host)[1]
Remote mouse	N/A	●	●	○
Remote printing	N/A	●	●	○
Graphics modes	N/A	VGA, EGA, CGA	VGA, EGA, CGA, Hercules	VGA
Security				
Password	●	●	●	●
Call-back	●	●	●	●
Blank host	●	●	●	○
Lock host	●	●	●	●
Directory access privileges	○	○	●	●
Utilities				
File transfer	Windows-based	●	●	●
Chat	Windows-based	●	DOS only	Windows or DOS
Session recording	○	●	●	○
Call logging	○	●	●	○

[1] Remote is not a TSR program.
[2] Additional memory on remote required for Windows.

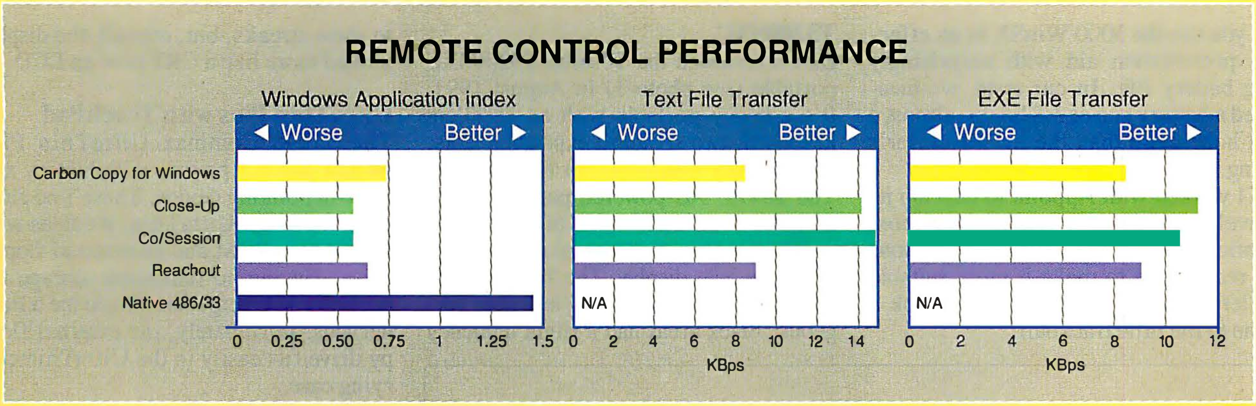


Figure A: *Carbon Copy for Windows was the fastest at running Windows applications via 9600-bps modem. Close-Up and Co/Session proved to be the best at file transfers. (N/A = not applicable.)*

that you'll see the same image on both displays even with ill-behaving applications.

The second class of products takes advantage of the structure of Windows to skirt some of its limitations. These packages intercept application calls to the graphics interface and send a copy of these messages to the remote system. The remote application uses these calls to build a duplicate screen.

Shipping messages consumes considerably less bandwidth than shipping bit maps. However, there is overhead in redirecting each graphics call and in decoding and acting on it on the remote system. Graphics-call interceptors are strongest where few Windows messages are required to perform an action onscreen (e.g., pulling down a menu).

There is another, less obvious advantage to this design. With either approach, screen updates are slow enough that repaints are obvious (at least at 9600 bps). But Close-Up updates the screen row by row, which is jarring. Graphics-call interceptors update object by object, which makes them more like running Windows locally. I found that the second approach made it easier to work with the delay imposed by remote control.

Quantitatively

I ran a set of benchmarks to measure these products' performance, with a 386SX/16 calling a 486/33 host through a 9600-bps phone connection. I ran our new Windows application suite for desktops, which exercises six different Windows applications. I also timed some file transfers, since fetching files from the office will probably be a common requirement.

The application benchmarks portray a cross section of performance (see figure A). The overall winner is Carbon Copy for Windows, with Reachout a solid second. Close-Up's and Co/Session's file compression and transfer protocols placed them neck-and-neck for first on file transfers.

But are any of these programs fast enough to use? As the benchmark figures show, the quickest package ran about half as fast as a local application. While faster modems or V.42bis compression would provide improvement, the response of any of these packages at 9600 bps is tolerable, and Carbon Copy for Windows is even pleasant. If all you have is your notebook's built-in 2400-bps modem, you'll want an external 9600-bps unit.

Oddly, only Carbon Copy for Windows is an all-Windows application. The others rely on a DOS-based remote application to control a Windows host. These packages let you run the control application on a relatively underpowered PC (e.g., a notebook), controlling sophisticated Windows applications in enhanced mode.

However, Carbon Copy for Windows' all-Windows orientation has its advantages. Its chat and file transfer utilities run and look like Windows applications. Reachout's chat runs under Windows, but the other packages require that you switch to a text-mode DOS application before you can transfer files or chat.

Carbon Copy for Windows is my overall favorite. It's fast, has good mouse response, and is stable in its supported modes. However, Carbon Copy for Windows does not support DOS or real-mode Windows, which may be a significant drawback in some applications. If remote control of both DOS and Windows were critical, I would choose Co/Session.

Steve Apiki is a BYTE technical editor with a B.S.E.E. from Rensselaer Polytechnic Institute. You can contact him on BIX as "apiki."

COMPANY INFORMATION

Microcom, Inc.
(Carbon Copy for Windows 1.0)
500 River Ridge Dr.
Norwood, MA 02062
(800) 822-8224
(617) 551-1000
fax: (617) 551-1968
Circle 1317 on Inquiry Card.

Norton-Lambert Corp.
(Close-Up 4.0)
P.O. Box 4085
Santa Barbara, CA 93140
(805) 964-6767
fax: (805) 683-5679
Circle 1318 on Inquiry Card.

Ocean Isle Software
(Reachout 2.0)
80 Royal Palm Blvd., Suite 202
Vero Beach, FL 32960
(800) 882-8664
(407) 770-4777
fax: (407) 770-4779
Circle 1319 on Inquiry Card.

Triton Technologies, Inc.
(Co/Session 6.0)
200 Middlesex Tpke.
Iselin, NJ 08830
(800) 322-9440
(908) 855-9440
fax: (908) 855-9608
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lets you use the 3000 WinSX as an effective presentation aid with surprisingly long battery life. In our tests, we measured a battery run of 3.8 hours, almost a full hour more than the manufacturer's rating.

TI worked with Appoint to develop its TravelPoint device, which is almost identical to the Thumbelina. The buttons are rearranged to make it more suitable for left-handers, but I just never took a shine to the little trackball.

T3200SXC

BYTE reviewed the Toshiba T3200SXC portable (see photo 1) in August 1991. It's a heavy portable with an excellent keyboard, two standard expansion slots, and quality construction throughout. The $8476, AC-powered package has a 20-MHz 386SX and 5 MB of RAM.

What makes this machine ideal for Windows is its display. The Toshiba 256-color TFT panel is nothing less than gorgeous. Black areas had a slight tendency to show streaks, but, overall, the display looked more like a CRT than an LCD.

UltraThin Plus with TouchPad

The $3995 Commax UltraThin Plus weighs just 4.5 pounds with battery and built-in pointing device. There's no floppy drive in the UltraThin; it comes with DR DOS in ROM and an external floppy drive. Having no removable storage for backup and emergencies made me a little nervous. Fortunately, the external floppy drive fits easily in the UltraThin carrying case.

While the UltraThin is a satisfactory machine vis-à-vis weight and size, its pointing technology leaves something to be desired. The upper left corner of the keyboard is a small removable module that you can replace with one of several options. By default, this unit contains just the external VGA and PS/2 mouse ports. My test unit came with a TouchPad cursor-control module (which also supports VGA and PS/2 ports). When you place your finger or a stylus on the pad, the cursor tracks in the direction you move. Four buttons next to the pad provide emulation of three mouse buttons and a "lock" button for click and drag. Using the TouchPad takes lots of practice, and I found it hard to control.

Merrily We Roll Along

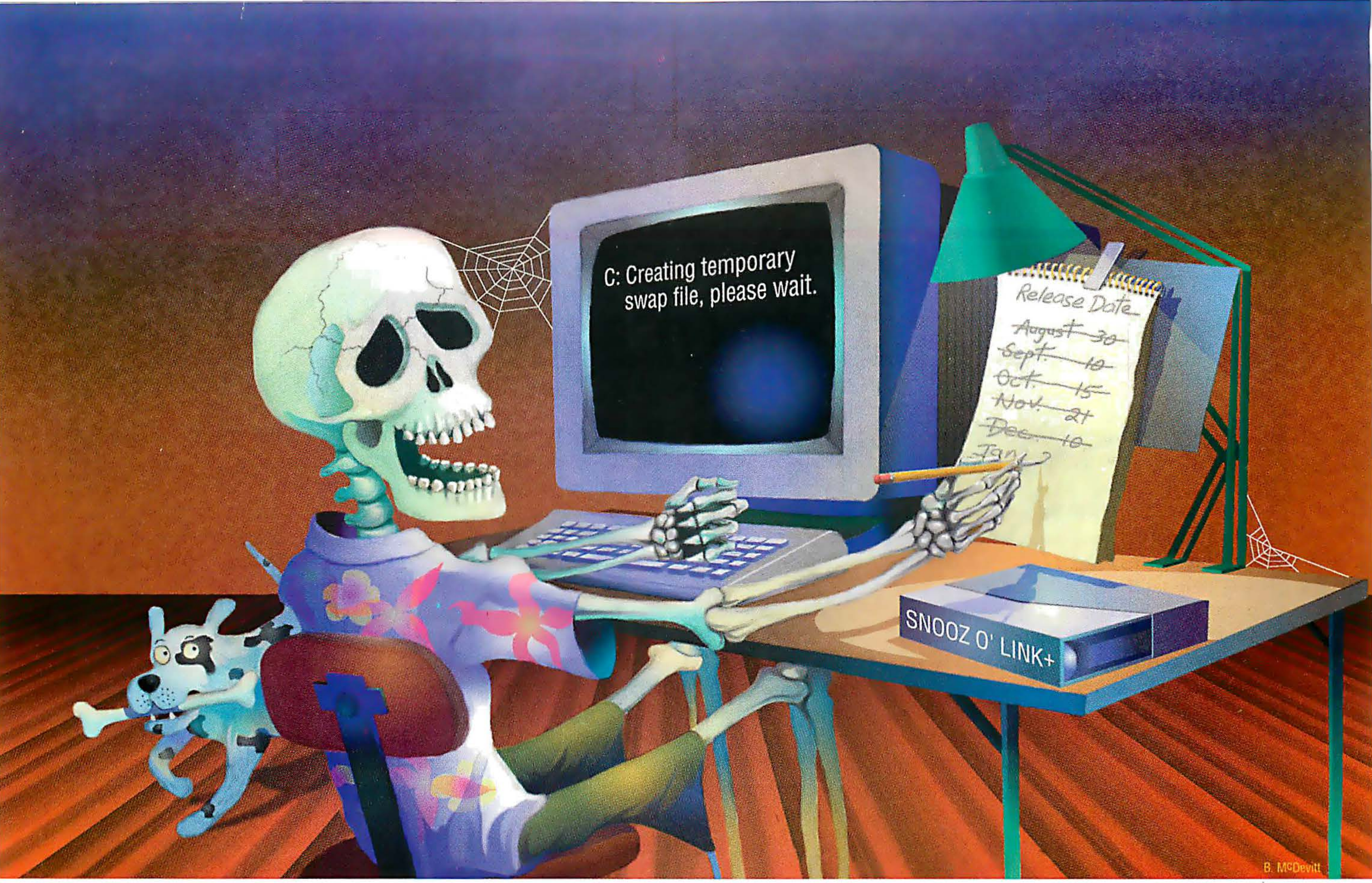
Using a mouse requires more than your eyes for feedback. When you're heading the cursor toward a menu you've used a hundred times, your hand "knows" just how far to roll. The physical memory that you develop with a mouse is something you may not get from a more stationary device; as motions get smaller, movement becomes less automatic.

Physical memory is an important part of running Windows (or typing, for that matter). Mouse alternatives tend to require less motion than mice, so they are harder to control. For a pointing device to be as comfortable as a mouse, the controls should be large and require a good amount of movement. For the best control, large cursor movements should require more controller motion.

I checked out six portable pointing devices and how they run under Windows (see photo 2). Because personal taste is probably the most important criterion in choosing a pointing device, I also solicited opinions from other BYTE editors to keep the evaluation even.

BallPoint Mouse and TrackMan Portable

Microsoft's $175 BallPoint Mouse is a palm-size trackball with a nice-size ball



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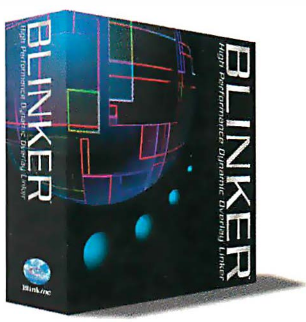
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Measuring Speed and Endurance

The latest round of processor and power-conservation design improvements has prompted enhancements in the way the BYTE Lab measures system performance. This review marks the introduction of a new notebook applications benchmark suite, version 3.0, and a significant upgrade to our portable-battery-life tests. Results are shown in figures 1 and 2 on page 212.

While our low-level DOS and Unix benchmarks have remained accurate measures of system speed, our version 2.1 applications suite has begun to show its age. The unprecedented popularity of Windows and applications that take advantage of DOS 5.0's improved memory-handling capability are areas that previous versions of our test suite did not address.

We have made three major changes. First, we've broken out applications into two major categories, DOS and Windows. Second, we have updated the applications we use to reflect recent upgrades. Third, and most noticeable, we have chosen a new baseline system; we retired our IBM AT standard and replaced it with a notebook baseline: the Toshiba T2200SX.

We continue to report the results of these tests as indexes based on the performance of the baseline. Therefore, our change in baseline means that you cannot compare the indexed performance results from these systems with the results of machines we've tested previously. However, you will be able to compare these results with those of portables that we'll test farther down the road.

BYTE's battery-life test relies on our laptop battery test rig (introduced in "Notebook Power Management at Its Zenith," December 1991). We place a fully charged machine in the tester and run it until it drops. Our test scenario simulates a word processing session, where text is saved several times in an hour and typing time alternates with idle periods. The systems are allowed to shut down hard drives and backlighting and can even put the CPU to sleep during idle segments. Machines with clever power-conservation techniques or SL designs will fare better than machines without. Our tests run at approximately 55 percent duty cycle; the machine is running 55 percent of the time and allowed to shut down for the other 45 percent. Naturally, battery life will vary, depending on the way you use the machine.

Since we introduced the new test, we have added an optical sensor to monitor the display and a third actuator to handle machines with shifted-power standby switches. The host software now allows us to realistically test battery life on any machine with a serial port regardless of its operating environment.



Photo 2: *A litter of mice and mouse-alikes: the Abacus NoMouse for Windows (screen); clockwise from right: the Logitech TrackMan Portable, Appoint Thumbelina Portable, Suncom ICONtroller, MicroSpeed MicroTrac, and Microsoft BallPoint Mouse.*

that you manipulate with your thumb. Four buttons sit around the trackball's edge so that two of them naturally fall where your index and middle fingers are, right or left handed. Before you use the BallPoint, you run a configuration program that tells the drivers which ball direction is up and which two buttons you plan to use.

Logitech's $169 TrackMan Portable is also a Microsoft-compatible trackball that clamps to the side of your computer's keyboard. You drive the ball with your thumb and click on the mouse buttons with your index and middle fingers. The placement of the buttons makes this primarily a right-handed device, although I've spoken to some who use it left-handed.

In both look and feel the TrackMan Portable is quite similar to Microsoft's BallPoint. The TrackMan's keyboard clamp is simpler to use than the BallPoint's, but I found that the BallPoint felt better to use.

NoMouse for Windows

Abacus's NoMouse for Windows is a $49.95 piece of software that takes over the cursor keys on your keyboard and

maps them to mouse movements. Moving the cursor with keys is like steering an Etch-A-Sketch—it's hard to make curves. Still, if you tweak the settings just right, it's possible to do some word processing or spreadsheet work without a mouse.

NoMouse will also work hand-in-hand with any other pointing device. The device is very handy for making fine adjustments in desktop publishing applications and for retouching pixels in Paintbrush.

Thumbelina Portable

Appoint's Thumbelina Portable is a tiny trackball mounted in a small plastic block that you hold in your hand. It sells for $99 in a package that includes a mounting bracket. You control the cursor with your thumb. To click, you move your thumb to one of two mouse buttons. A "lock" button provides for click and drag operations.

While the device certainly is portable, most of the editors never felt at home with the Thumbelina.

MicroTrac

MicroSpeed's $89.95 MicroTrac is a small trackball mounted in a flat base. You can hold the unit in your hand and roll the ball around with your thumb à la Thumbelina, or you can put the thing on your desk and use your fingertips. Tiny buttons on the top and sides provide left, right, and locking mouse buttons.

Unfortunately, like the Thumbelina, the MicroTrac proved a little too tiny to control.

ICONtroller

The $99 ICONtroller from Suncom is the most innovative of the add-on pointing devices. It's a tiny digital joystick that attaches to the side of your keyboard with Velcro tape and emulates a Microsoft Mouse.

Three buttons provide your mouse buttons, and a smaller button on the tip of the joystick emulates one of the three. You control the cursor speed by picking one of four accelerations with a speed button and the force you use to move the stick.

Highlighted Selections

Innovative pointing devices are the features that most distinguish these systems. My favorite overall was the GridCase 1550SX and its Isopoint, and the composite BYTE editor opinion was that the Microsoft BallPoint Mouse is still the best of the stand-alone pointing devices.

However, the GridCase is a little too hefty to carry around on a regular basis. TI's TravelMate 3000 WinSX might have been my favorite if it had had a better pointing device. I found the best combination of weight, screen, and pointing device in the Everex Tempo Carrier. The Tempo's KeyMouse is ideal for word processing in Windows, probably the application that you'll use most on the road.

If you must have color and battery power is not a requirement, the Toshiba T3200SXC is your best bet. It has the best TFT display, and it costs considerably less than its color competition. ■

Howard Eglowstein is a BYTE Lab testing editor who holds an S.B. from MIT. Contact him on BIX as "heglowstein."

COMPANY INFORMATION

Abacus Software
(NoMouse for Windows)
5370 52nd St. SE
Grand Rapids, MI 49512
(800) 451-4319
(616) 698-0330
Circle 1321 on Inquiry Card.

Appoint, Inc.
(Thumbelina Portable)
1332 Vendels Cir.
Paso Robles, CA 93446
(800) 448-1184
(805) 239-8976
Circle 1322 on Inquiry Card.

Aquiline, Inc.
(Arima SN386SL)
449 Main St.
Bennington, VT 05201
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(802) 442-1526
fax: (802) 442-8661
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fax: (908) 469-4578
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Commax Technologies, Inc.
(UltraThin Plus)
2031 Concourse Dr.
San Jose, CA 95131
(800) 526-6629
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Dolch Computer Systems
(C-P.A.C. 386SX-20C)
372 Turquoise St.
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Everex Systems, Inc.
(Tempo Carrier)
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Grid Systems Corp.
(GridCase 1550SX)
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Fremont, CA 94537
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Isopoint Technologies
(Isopoint)
2391 American Ave.
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Logitech, Inc.
(TrackMan Portable)
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Fremont, CA 94555
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Microsoft Corp.
(BallPoint Mouse)
1 Microsoft Way
Redmond, WA 98052
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(206) 882-8080
fax: (206) 883-8101
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MicroSpeed, Inc.
(MicroTrac)
44000 Old Warm Springs Blvd.
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NEC Technologies, Inc.
(ProSpeed 486SX/C)
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(ICONtroller)
6400 West Gross Point Rd.
Niles, IL 60648
(708) 647-4040
Circle 1334 on Inquiry Card.

Texas Instruments
(TravelMate 3000 WinSX)
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(800) 527-3500
(512) 250-7111
Circle 1335 on Inquiry Card.

Toshiba America Information Systems, Inc.
(T3200SXC)
9740 Irvine Blvd.
Irvine, CA 92718
(800) 334-3445
(714) 583-3000
Circle 1336 on Inquiry Card.

CAPTAINS OF CRUNCH

The BYTE Lab looks at the top spreadsheet programs for DOS, Windows, and the Mac

RAYMOND GA CÔTÉ AND DAVID L. EDWARDS

Once dominated by mighty Lotus 1-2-3, the spreadsheet playing field is intensely competitive these days. Spreadsheets come in so many variations and are designed for so many platforms in the personal computer environment that making an informed buying decision truly presents a challenge. Selecting the right program demands identifying key features; understanding how well the implementation of particular features meshes with your work style, financial requirements, and analytical needs; and deciding what sorts of special tools will make it easier for you to present information clearly.

Those of us who cut our teeth on Hollerith cards remember how difficult it was to turn final output into something resembling what we saw on-screen. Fortunately, things change. Just as word processors have evolved into highly visual programs, so, too, have spreadsheets.

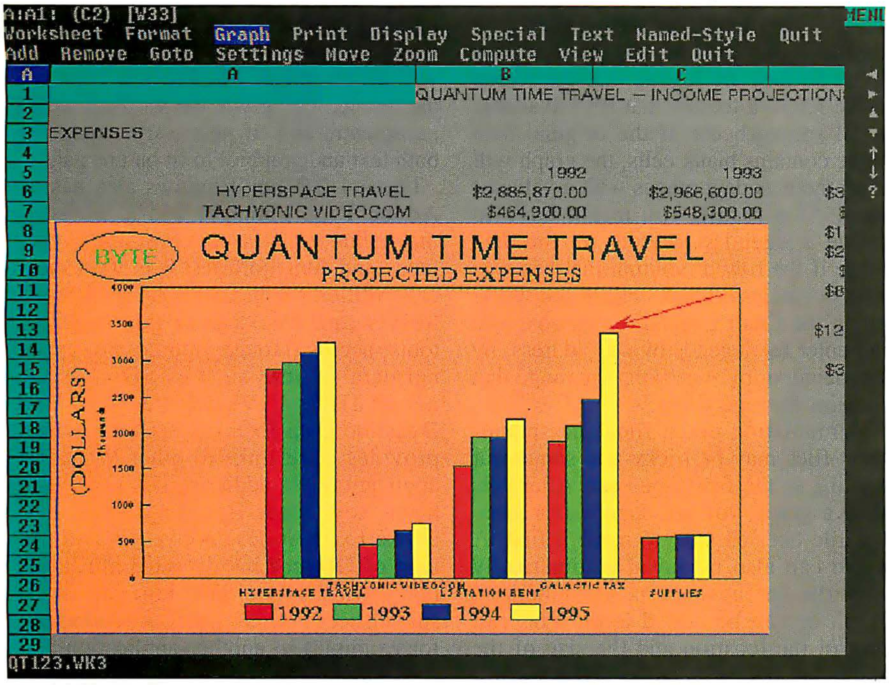
For this BYTE Lab Product Report, we selected programs that run under DOS or Windows 3.0, or on the Macintosh; most have WYSIWYG capabilities. The list includes CA-SuperCalc 5.1, Excel 3.0, Lotus 1-2-3, Lucid 3-D 2.5, Quattro Pro 3.0, Resolve 1.0v2, and Wingz 1.1a. All are packed with features for handling numbers, but some offer superior graphics tools and presentation capabilities, as well. Certainly an essential requirement for any spreadsheet is the ability to generate graphs from the data your worksheets contain. The applications examined here do quite well at converting data to charts, but they differ in the extent to which they let you manipulate graphs and charts.

In evaluating each program, we paid careful attention to its user interface and ease of use. Options usually taken for granted—automated program installation, smooth navigation within a worksheet, and the ability to quickly generate charts and view data in different formats—were high on our list of desirable features. But we also looked at how easy the programs' other major features were to learn and use. After all, an awesome calculation function is nearly useless if you can't figure out how to make it work.

LOTUS 1-2-3

FOR DOS

Sales figures indicate that Lotus 1-2-3 still is the king of DOS spreadsheets. The latest DOS package, release 2.3, is a low-end marvel that's powerful enough to ensure loyalty to the crown among the masses. Release 3.1, slower and heavier on high-end features than release 2.3, is a top seller among corporate number crunchers. But in the realm of Windows and the Mac, Lotus 1-2-3 is an upstart challenger that must prove itself against established packages such as Excel and Wingz.



With millions of die-hard DOS users worldwide faithfully awaiting the next upgrade from Lotus, you'll be in good company if one of the three versions of 1-2-3 for DOS is your final choice. Which of the trio is right for you depends on how much processing power your system has and whether you prefer the more intuitive, polished graphical user interface of the Windows version. The newest 1-2-3 release extends the long arm of Lotus to include Macintosh users. Cross-platform mobility and ease of use are two of the new arrival's biggest selling points.

Lotus 1-2-3 Release 2.3

The latest DOS version of Lotus 1-2-3, release 2.3, is a big wonder in a small package. Lotus has managed to cram myriad graphics tools into a program that will run on low-end systems without sacrificing speed. The program will run on older 8088-based PCs and touts an interactive WYSIWYG display and presentation-quality output with page preview capability. It shares many of the same basic features found in 1-2-3 release 3.1 but lacks Solver and Backsolver, DataLens technology for accessing external data sources, SmartIcons, and a three-dimensional worksheet display.

Release 2.3 does, however, include provisions for using more than 100 scalable fonts in a single worksheet, a built-in word processor, a palette of 224 colors and fill patterns for enhancing graphs, and the ability to automatically wrap text around graphs. Release 2.3 also provides an on-line tutorial, context-sensitive help, and what Lotus calls enhanced expanded memory, a memory management system that can accommodate spreadsheets as large as 12 MB.

Lotus 1-2-3 Release 3.1

The GUI for Lotus 1-2-3 release 3.1 for DOS is similar to that for release 2.3: the classic menu on the top line with pull-down choices from each command. And, again like release 2.3, it lacks the scroll bars, radio buttons, and sculpted window frames found in 1-2-3 for Windows.

An add-in program for 3.1 lets you customize screen colors and worksheet fonts, as well as do fancy formatting of data. As a result, 1-2-3 3.1 can print professional looking reports. The latest update, 3.1+, incorporates the spiffy graphical features of 1-2-3 2.3.

Release 3.1 goes beyond 2.3 in many other areas, offering advanced macro commands, a worksheet and cell indicator, calculation indicator, new graphing options, advanced printing functions, and the ability to search and replace information in a range of cells. A 286 microprocessor is the minimum required to run this version. In our tests of floating-point and integer calculations, the calculation engine for Lotus 3.1 proved slower than that of the speedy release 2.3.

BYTE ACTION SUMMARY

■ WHAT THEY DO

These packages provide you with tools for analyzing and calculating complex sets of numerical data. To varying degrees they incorporate functions that let you turn this data into visually meaningful information.

■ WHAT YOU'LL LIKE

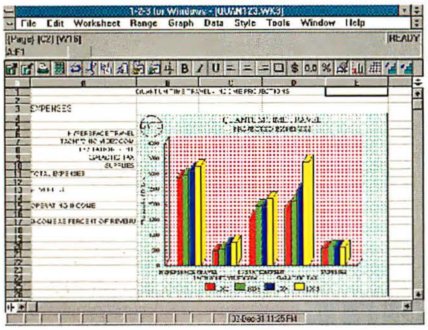
Spreadsheets not only analyze numbers; the more sophisticated programs now on the market offer slick powerful presentation tools. Those products equipped with graphical interfaces further simplify analytical procedures.

■ WHAT YOU'LL DISLIKE

With the increase in calculation and presentation power comes a steep learning curve. Some spreadsheet packages are just plain hard to learn.

■ RECOMMENDATIONS

For older machines with 512 KB of memory, nothing beats Quattro Pro. Lotus 1-2-3 release 2.3, likewise, offers speed and basic graphics functions to low-end DOS users. For sheer calculation speed, however, consider the very graphical Wingz . Under Windows and on the Mac, Excel offers elegance and ease of use; Lotus, 1-2-3 compatibility; and Wingz, throughput.



LOTUS 1-2-3 1.0A

FOR WINDOWS

What stands out most visually in Lotus 1-2-3 for Windows are its new Smart-Icons: a suite of over 70 worksheet and graphing buttons that you can customize to automate basic spreadsheet functions. You can, for example, assign a macro or a frequently used operation to a button; if you want help figuring out what a button does, you can simply point to it and click the right mouse button.

Lotus 1-2-3 for Windows is essentially a graphical version of high-end release 3.1 and, like release 3.1, bears some resemblance to older 1-2-3 versions. The old guard who prefer the traditional way of doing things will appreciate that the program includes a provision for accessing the classic 1-2-3 menus with the slash key (/). The command keystrokes remain the same, and old worksheet files are completely compatible with the new 1-2-3 for Windows.

The package's graphing techniques include the ability to insert and display an unlimited number of 1-2-3 graphs anywhere in the spreadsheet; the graphs are updated automatically as worksheet data changes. You can place PIC and CGM graphics files and freehand drawings in a worksheet and annotate graphs with text and simple geometric shapes, as well as paste in graphics from the clipboard.

Creating graphs is easy. You simply select a valid range of data from your worksheet, pick the Graph and New options, type a name for your graph, and press Enter. The chart first generates a line graph; you then have the option of selecting one of more than 200 combinations of styles—among them 22 3-D graph formats. To view the graph separately at a later time, you have to select it from the active list of graph names under Graph View.

To change the elements in a graph, the named graph window must be active. Pressing Control-F6 toggles the active window, alternately showing the graph and the worksheet; clicking on the graph twice also toggles the active window. If the axis text labels in your spreadsheet are long, they will be staggered on two levels so they are legible (see the screen to the left)—a feature that isn't available in all spreadsheets. If the original data range contains blank cells, the graph will chart them as data ranges with a value of zero. As a result, you might have to define a legend separately for the data range if the row or column that has axis labels contains a blank cell. When working in the Chart Legend dialog box, you can enter the legends by cell address, by text name, or by specifying the range that contains the legend labels.

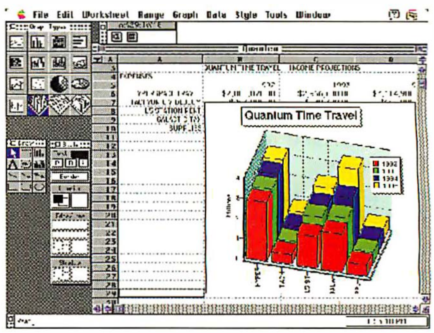
Manipulating graph files and spreadsheet files may be tricky and somewhat baffling to the first-time user. After creating a graph, you can save it as a separate file but you have to name it first. A graph can also be saved automatically with the spreadsheet as an embedded graph or can be added later. You can control the location and the size of the graph, but once it is embedded you can't annotate it, nor can you change its appearance except by altering the spreadsheet data or naming the graph and opening it as the active window. Once an embedded graph and spreadsheet are saved together, they are forever married. If you close the file and then reload it, you'll find the ever-faithful embedded graph, obscuring the data that lies beneath it (if you happened to place it on top of a portion of your spreadsheet).

The procedure for opening a file isn't as easy as it could be. If you type the directory, filename, or file extension incorrectly, the program's File/Open window displays an error message saying the file doesn't exist. At that point, the only available options are Help or OK, but neither allows a second try. You must go back to the File menu and re-enter the directory or filename (the default Lotus 1-2-3 directory always takes precedence)—an annoying quirk to say the least.

If you are working with an imported file with a WK1 extension (the 1-2-3 release 2.3 file format) and create a graph you want to save, you will likely get an error message saying, "Incompatible worksheet information lost during saving." Don't panic. No data has been lost; the message is merely a warning, though it may not appear that way. You receive a second chance to save the worksheet under a different file extension or in the native file format for the Windows version of 1-2-3, WK3.

One of the program's most convenient features is the automatic fit-to-page option. Often when you work with spreadsheets, page breaks are unavoidably inserted in your spreadsheet. They can be a nuisance when you want to print what you see on-screen. File Preview comes to the rescue, letting you see the Page Setup parameters and, if necessary, compress both text and graphics to fit on one page.

Lotus 1-2-3 for Windows also has an Adobe Type Manager add-in program that includes 13 scalable PostScript typefaces and font libraries; 3-D worksheet capabilities for handling large models; Solver and Backsolver goal-seeking tools; access through DataLens to external data sources such as SQL Server, dBase III and IV, and Paradox; and Dynamic Data Exchange (DDE), which provides live links to other Windows applications. In addition, 1-2-3 for Windows now reads Excel 3.0 files, but, unlike Excel, it does not yet take advantage of Object Linking and Embedding (OLE), a protocol that lets you place spreadsheet data (a graph or worksheet, for example) in another application and then launch the source program (in this case Excel) from within that application. Lotus 1-2-3 for Windows will give you everything you need to produce a winning presentation or report. Even most "classic" users will like it.

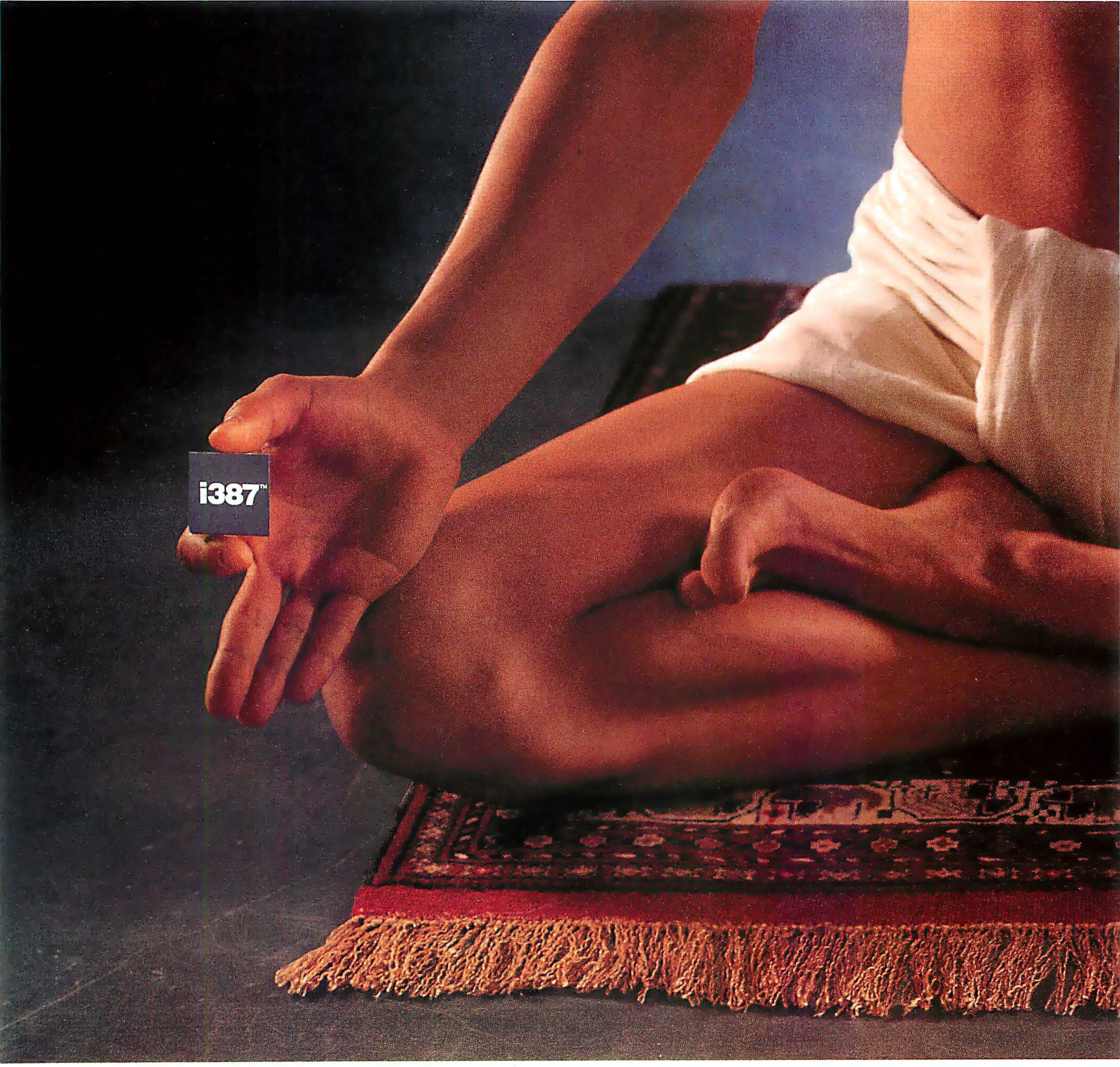


LOTUS 1-2-3

FOR MACINTOSH

Lotus delivered version 1.0 of 1-2-3 for the Macintosh just as we finished this product roundup, so we couldn't give it as long a look as we would have liked. Next to "1-2-3 compatibility," the phrase that best describes this newest Lotus product is "user configurable." If you see something you don't like on the screen, you probably can change it.

With Lotus 1-2-3 for Macintosh, Lotus has fallen in love with command and status boxes and tear-off menu palettes. The latter are used extensively to control such functions as graphing, drawing, and



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Spreadsheet Features

The plethora of spreadsheet programs on the market makes it difficult to make an informed buying decision. Comparing products feature for feature can help. ● = yes; ○ = no; N/A = not applicable.

	DOS SPREADSHEETS					WINDOWS
Product	**CA-SuperCalc**	**Lotus 1-2-3**	**Lotus 1-2-3**	**Lucid 3-D**	**Quattro Pro**	**Excel for Windows**
Version	**5.1**	**2.3**	**3.1**	**2.5**	**3.0**	**3.0**
Company	Computer Assoc. International	Lotus Development Corp.	Lotus Development Corp.	Lucid Corp.	Borland International	Microsoft Corp.
Price	$149	$495	$595	$99.95	$495	$495
Upgrade Price	$149	$150	$150	$49.95	$99.95	$129
Minimum System Requirements						
Processor	8088	8088	286	8088	8088	286
Memory	512 KB	384 KB	1 MB	256 KB	512 KB	1 MB
Disk space	2.2 MB	5 MB	6 MB	330 KB	5 MB	2 MB
Operating system version	DOS 3.0	DOS 2.1	DOS 3.0	DOS 3.1	DOS 3.3	Windows 3.0
Recommended System Requirements						
Processor	8088	8088	286	8088	8088	286
Memory	640 KB	512 KB	1.5 MB	640 KB	640 KB	2 MB
Disk space	2.2 MB	6.4 MB	8 MB	500 KB	5 MB	6 MB
Operating system version	DOS 3.3	DOS 5.0	DOS 5.0	DOS 3.1	DOS 3.3	Windows 3.0
Features						
Network capability	●	●	●	●	●	●
Data-import formats	dBase, DIF, text, WK1, XDIF	dBase, DIF, WK1, WKS, SYLK, text	dBase, DIF, WK1, WKS, SYLK, text	DacEasy, dBase, text, WK1	WK1, WKS, dBase, Paradox, Reflex	Clipboard, dBase, DIF, SYLK, text, WK1, WK3, WKS
Graphics-import formats	None	CGM, FMT, PIC	CGM, FMT, PIC	LCD	CGM	Clipboard
Data-export formats	dBase, DIF, text, WK1, XDIF	dBase, DIF, WK1, WKS, SYLK, text	dBase, DIF, WK1, WKS, SYLK, text	DacEasy, dBase, text, WK1	WK1, WKS, dBase, Paradox, Reflex	Clipboard, dBase, DIF, SYLK, text, WK1, WK3, WKS
Graphics-export formats	CGI, CGM, PICT, PostScript, Ventura Publisher	CGM, FMT, PIC	CGM, FMT, PIC	IMG, PCX, MAC, LCD	EPS, PCX, PIC	Clipboard
Automatic graph updating	●	●	●	●	●	●
Embedded graphs	○	●	●	○	●	●
Print preview	○	●	●	○	●	●
Output options						
Slide maker	●	○	○	○	○	●
Camera	●	○	○	○	○	●
Film recorder	●	○	○	○	○	●
Plotter	●	●	●	○	○	●
Maximum sheet size (rows x columns)	999 X 255	256 X 8192	256 X 8192	9999 X 254	8192 X 256	16,384 X 256

SPREADSHEETS		MACINTOSH SPREADSHEETS			
Lotus 1-2-3 for Windows 1.0a Lotus Development Corp.	**Wingz for Windows 1.1a** Informix Software	**Excel for the Macintosh 3.0** Microsoft Corp.	**Lotus 1-2-3 for Macintosh 1.0** Lotus Development Corp.	**Resolve 1.0v2** Claris Corp.	**Wingz for Macintosh 1.1a** Informix Software
$595	$499	$495	$495	$399	$399
$150	N/A	$129	N/A	N/A	$37
286	286	68000	68000	68000	68000
2 MB	2 MB	1 MB	2 MB; 3 MB under System 7.0	1 MB	1 MB
5.5 MB	2 MB	3 MB	3.9 MB	2 MB	2 MB
Windows 3.0	Windows 3.0	System 6.0.3 or Finder 6.0.1	System 6.0.3 or 7.0	System 6.0.5 or AUX 2.0	6.0.2
286	286	68000	68000	68020	68020
4 MB	3 MB	2 MB	2 MB; 3 MB under System 7.0	2.5 MB	2 MB
5.5 MB	2 MB	3 MB	6.5 MB	3.2 MB	5 MB
Windows 3.0	Windows 3.0	System 7.0	System 6.0.3 or 7.0	System 7.0 or AUX 2.0	6.0.2
●	●	●	●	●	●
dBase, DIF, SYLK, text, WK1, WK3, WKS	BIFF, DIF, SYLK, text, WK1, WK3	Clipboard, dBase, DIF, SYLK, text, WK1, WK3, WKS	WK1, WK3, WKR, WR1, WKS, Excel, dBase, text	DIF, SYLK, text, Wingz, WK1, WK3	DIF, SYLK, text, WK1, WK3
CGM, PIC, Clipboard	BMP, GIF, PICT, PICT 2	Clipboard	Clipboard, Publish and Subscribe	PICT, PICT 2	BMP, GIF, PICT, PICT 2
dBase, DIF, SYLK, text, WK1, WK3, WKS	BIFF, DIF, SYLK, text, WK1, WK3	Clipboard, dBase, DIF, SYLK, text, WK1, WK3, WKS	WK1, WK3, Excel 2.2, dBase, text	DIF, Excel, SYLK, text, Wingz, WK1, WK3	DIF, SYLK, text, WK1, WK3
CGM, PIC, Clipboard	Clipboard	Clipboard	Clipboard	PICT, PICT 2	Clipboard
●	●	●	●	●	●
●	●	●	●	●	●
●	●	●	●	●	●
●	○	●	●	●	○
●	○	●	●	●	○
●	○	●	●	●	○
●	○	●	●	●	○
8192 X 256	32,768 X 32,768	16,384 X 256	256 X 8192	>1 billion cells	32,768 X 32,768

setting styles. If you aren't careful, your screen may quickly end up showing more palettes and menu options than spreadsheet information.

The program's default settings produce wonderful graphics. The colors, shading, and placement of items is excellent. All graph items—titles, legends, axis notations, and so on—are treated as objects. To move an item, you simply drag it to where you want it. To change it, you double-click on it to bring up an editing dialog box. You don't like the color combinations? You can change them one at a time. Even though the default graphs are excellent, you can make them look better by adding new fonts from the copy of Adobe Type Manager 2.0.3 included with each package.

Context-sensitive help is linked to all the program's dialog boxes. To access the online help pertinent to your current situation, you simply click on the question mark in the upper-right portion of the box. This is a very convenient and nonintrusive addition to the Mac's standard interface.

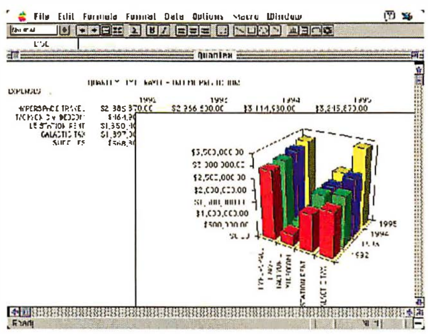
Lotus 1-2-3 for Macintosh has all the features we've come to expect in a high-end graphical spreadsheet: the ability to annotate a spreadsheet by adding graphics—an arrow that points out a certain cell, for example—buttons and text fields with which you can associate macro commands, support for true 3-D spreadsheets, a well-rounded macro language, and an iterative solver.

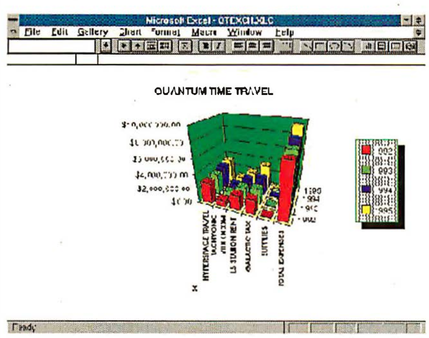
The program's performance on the BYTE Lab benchmarks indicate that Lotus 1-2-3 for Macintosh isn't a top performer when it comes to throughput. What you get instead is the ability to continue working on a spreadsheet while a recalculation goes on in the background. But although not having to wait for recalculation seems like an attractive idea, in practice we found ourselves waiting anyway because we needed to see the result of a computation before making further changes to our spreadsheet. How helpful this feature will prove depends largely on how you work. For us, the ability to abort a recalculation and quickly turn manual recalculation on and off from the keyboard seems much more useful.

The principal beneficiaries of this Lotus 1-2-3 version will be business users already running 1-2-3 on PCs. Now they can share files and macros with their coworkers who use Macs. The procedure involves shuttling files across a network or relying on Macs with floppy drives that can read PC disks, but taking 1-2-3 worksheets from PCs to Macs is about as easy as cross-platform exchanges get.

1-2-3 for Macintosh also is one of the first packages to really tap the capabilities of System 7.0, most notably its Publish and Subscribe options. With this feature, you can "publish" data—perhaps a worksheet or graph—that other applications can "subscribe" to. Someone else—maybe the person who prepares reports for the CEO—can then subscribe to that material and place it in a document. If you make a change to the published information, the subscriber's copy changes, too. This is just one practical example of advantages offered by putting System 7.0 to good use.

Despite sluggish performance, Lotus 1-2-3 for Macintosh feels right because so many of its operations are intuitive. Let's hope that the next release pays close attention to maximizing the throughput of the computing engine. Because, after all, spreadsheets are meant to boost productivity.





EXCEL 3.0

FOR THE MACINTOSH AND WINDOWS

Microsoft's Excel is one of the graphically oriented, feature-rich competitors that has Lotus Development looking over its shoulder. The price of this program's visual sophistication, though, appears to be speed. On the Macintosh, Excel was a poor performer in both file loading and computational speed. Under Windows, file loading speed also was poor, but computational speed was average.

Microsoft has done a good job porting Excel to the Windows 3.0 environment. Most everything we say about Excel for the Macintosh applies to the Windows version, with the notable exceptions of performance, database links, and DDE.

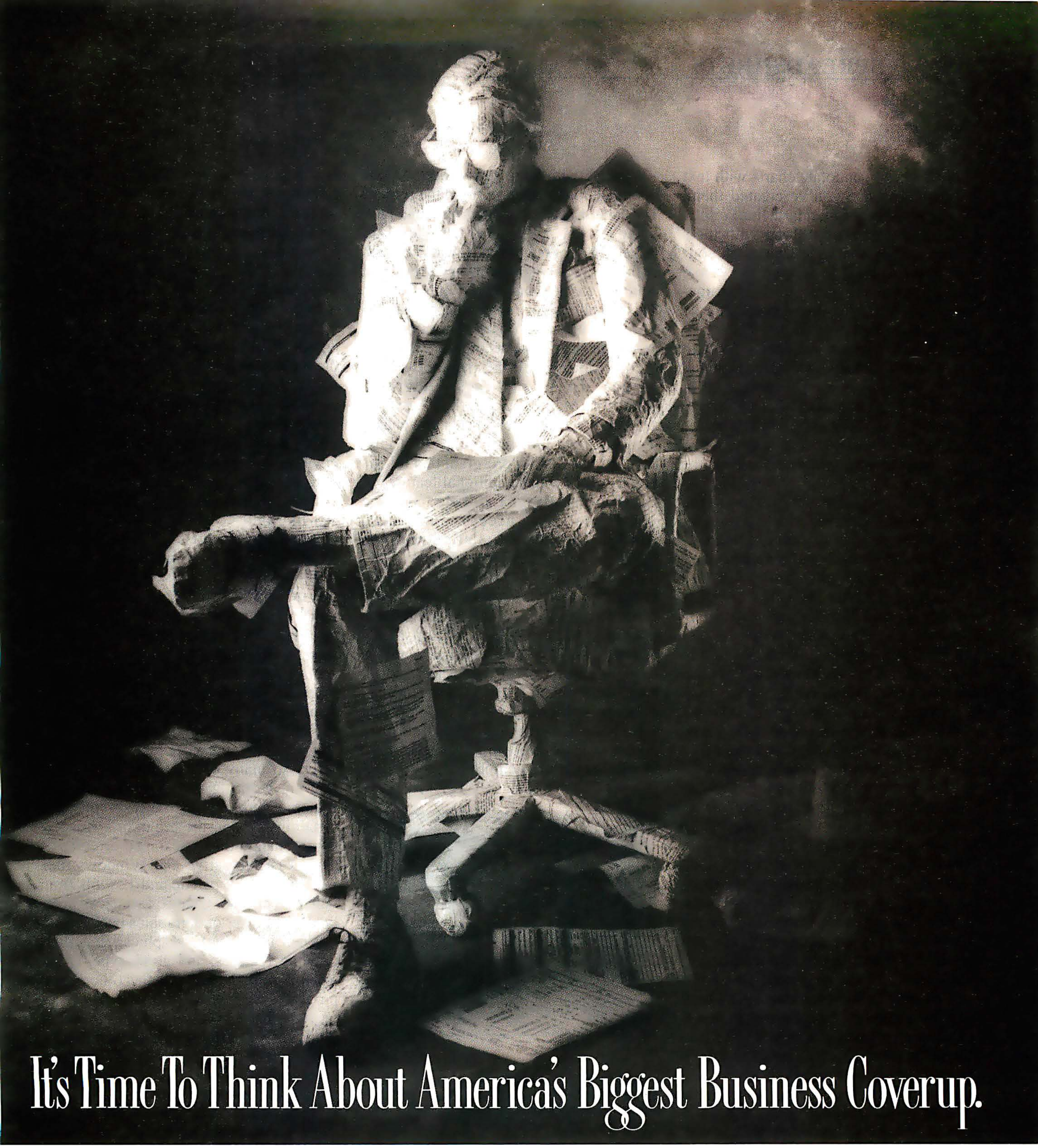
Like the Macintosh version, Excel for Windows gives you access to external databases; however, it relies on a separate program called Q+E to provide the link. You get interactive dialog boxes to assist you in naming the fields to extract, the ability to attach search criteria to every field, and macros. But you access a database by creating DDE links between your spreadsheet and Q+E. Although Excel provides a special Q+E macro library to simplify the interface, it would be much nicer if the database were integrated into Windows—the way it is for the Macintosh version.

While other Windows spreadsheets' dynamic linking capability starts and ends with DDE, Excel lets you take advantage of OLE by placing a worksheet or graphic in a document created with another OLE-compliant application, such as a word processor. If, while working in the word processor, you need to change the worksheet, you just double-click on it and Excel fires up; when you're done making changes, you can click out of Excel and be back in your word processor.

All in all, Excel 3.0 for Windows provides a good mix of analysis and presentation tools. It may not be the fastest spreadsheet when it comes to some operations, but it's easy to use once you learn its few idiosyncrasies. The program's Toolbar, which lets you access functions by clicking on an icon, is a great time-saver.

Navigating an Excel worksheet on either the Macintosh or Windows is quick and smooth. For procedures such as recalculation and chart updates, the program displays a percent-completed message in a status box. Excel lets you create a separate window for charts or embed them in a worksheet by simply making a palette selection. Creating a chart in a separate window is similar but requires selecting the New option from the File menu and then specifying the chart type; some users have found this to be one of the most nonintuitive processes in Excel. Charts created as separate windows are not saved with the spreadsheet, but rather in a file internally linked to the spreadsheet. Changes made to the spreadsheet appear in the chart the next time you open it. Before changing any features of an embedded chart, you must first expand it into a separate window. After making the changes, you must close the window to display the updated embedded chart.

continued



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Circle 33 on Inquiry Card.

You can easily annotate charts with text and graphics once you've created them. Excel provides the standard line, circle, and box drawing tools along with tools for improving the appearance of your type. We managed to change the colors of the bars in our sample chart, something few of the other spreadsheets reviewed allowed us to do.

Another innovation is Excel's Toolbar. Like Lotus's SmartIcons, this graphical bar lets you access certain commands or procedures with a single click of the mouse. To specify type styles, make other formatting choices, or access Autosum, for instance, you just click on the appropriate Toolbar icon.

In addition, Excel has the unique ability to change the value of a spreadsheet cell when you alter its value while creating a chart. Pressing the Control key (the program's command key) and clicking on a bar or data point, brings up a handle that you can grab and move. As you work, the updated value is displayed in the upper-left corner of the spreadsheet. This technique has limitations, however. First, not all charts may be manipulated. In particular, we couldn't directly manipulate 3-D charts. Second, if a chart element is linked to a cell containing a formula, you must be ready to tell Excel which cell in the formula to change to get the new value. Excel then uses its built-in Solver to compute a new result.

What Excel lacks in speed it makes up for in features. The program provides access to external databases through Apple's Data Access Language for the Macintosh. This arrangement gives you access to Sybase, Ingres, Rdb, Informix, Oracle, and dBase data, and you don't need to learn a complex data query language to use DAL. Excel provides interactive dialog boxes in which you can specify which fields to extract and then attach simple search criteria to each field. Advanced users may perform sophisticated database searches using SQL, and all DAL functions are available through macro commands.

Another of the program's advanced functions is Solver. This feature, which is similar to Lotus 1-2-3's Solver, lets you specify the result you want and then solve for the input to generate that result. You provide Solver with a target result, several starting inputs, and a number of constraints—cells that must remain within a particular range, for instance. When you start Solver, it repetitively recalculates the spreadsheet until all your specified conditions are met.

Working with large spreadsheets? Have too much information to fit on the screen? Try using Excel's outlining function. Outlining lets you define up to seven levels of indenting on your spreadsheet. You can collapse and expand outlined rows and columns to hide and display information. This simplifies your spreadsheet organization and allows you to quickly move around in large amounts of information.

For working within large networked groups, Excel provides integrated Microsoft Mail support, which lets you send and receive spreadsheets and charts. You also can take advantage of a customized installation pro-gram that allows you to select which additional features of Excel to install: tutorial, help, equation solver, database access, and macro library. The full installation requires roughly 3 MB of disk space.

The sheer number of features available in Excel for the Macintosh might have made it intimidating, but Microsoft has managed to fashion a program that's easy to use. If you're familiar with the basic operation of a spreadsheet, you'll have no problem learning this complex package. It doesn't have all the graphical whizbang of Wingz, but its learning curve is a gentle knoll compared to Wingz' precipitous climb.



QUATTRO PRO 3.0

FOR DOS

Borland International's outstanding entry in the spreadsheet domain offers bells and whistles at hurricane force. With Quattro Pro 3.0, the company apparently was determined to offer more functions, performance, and presentation effects than most other spreadsheets around. This is a product that delivers. If you need powerful visuals to get your financial message across, you'd be wise to take a close look at Quattro Pro.

Despite advanced linking and consolidation features, the ability to annotate any portion of a graph, 24 slide-show transition effects, built-in sound effects, banner printing across continuous paper—not to mention many more features that make data manipulation and windowing easier to use and documents and presentation materials easier to prepare—Quattro Pro is economical on memory. Borland's distributed memory allocation system called VROOMM (Virtual Runtime Object-Oriented Memory Manager) makes it possible to take advantage of all these features on an 8088-based system with 512 KB of memory. And the program is Windows compatible.

It's a joy to work within the Quattro Pro environment, with its slick Windows-like buttons and 3-D graphical interface. Or, if you prefer, you can work with classic 1-2-3-like pull-down menus. Either way, Quattro Pro provides a fully integrated WYSIWYG display and screen preview that shows on-screen exactly what you'll get in print—in portrait or landscape mode. Quattro Pro even has a Zoom feature that lets you increase the amount of information displayed by up to 200 percent or decrease it to 25 percent. What is more, you can toggle between a chart and a spreadsheet with a single keystroke.

Creating graphs is extremely fast. But it can seem complex because Quattro Pro offers so many options you might think you are working in a drawing package that just happens to have spreadsheet capability. Using the program's Annotator to change the appearance or color of graphs is interactive and Windows-like. With a 16-color palette and 12 tools from which to choose, Quattro Pro packs nearly all the power of a graphics package.

When it comes to graphics versatility, drawing features, and graph type, Quattro Pro outperforms all the other DOS programs we looked at. You get 10 types of two-dimensional graphs and five kinds of 3-D graphs, but unlike Wingz, the program cannot do polar and contour graphing.

You can link graphs to more than one spreadsheet or insert them directly into your worksheet. Although the initial graph is displayed in black and white, you can drop in color or fill patterns by making selections within the Graph Overall menu. The options you select do not remain checked when you return to the menu.

If you are looking for the most versatile, integrated spreadsheet and graphics package available today for DOS machines—and you want powerful linking capability, analytical tools, and data consolidation as well as plenty of presentation and publishing punch—Quattro Pro should be near the top of your list.

continued

Borland ranked best
Quattro Pro beats Lotus 1-2-3

Two recent industry studies objectively confirm the facts: Customers rank Borland best among software companies, and Quattro® Pro outperforms *all* Lotus® spreadsheets.

Borland: The technology leader.

Buying software shouldn't be an act of blind faith. Before purchasing your next spreadsheet, take a hard look at the company behind it. Bigger is not better!

Because Borland is smaller than our competitor, we work smarter, we try harder, and it's paying off: Borland was just ranked "Best Application Software in Customer Satisfaction, in Small and Medium Sized Businesses," in the prestigious J.D. Power and Associates survey.

Who would you rather buy your next spreadsheet from?

J.D. POWER AND ASSOCIATES

APPLICATION SOFTWARE
CUSTOMER SATISFACTION INDEX℠

June 6, 1991

1. BORLAND
2. WORD PERFECT
3. CLARIS
4. ALDUS
5. MICROSOFT
6. LOTUS

Quattro Pro: The standard of excellence.

InfoWorld reviews confirm what more than one million PC users already know: Quattro Pro is the best DOS spreadsheet that money can buy. Better than *any* Lotus spreadsheet including their recently released version 2.3.

Just check out the *InfoWorld* review results below. Quattro Pro wins in comparison to Lotus 1-2-3® hands down in *InfoWorld* and with more than 1,000,000 enthusiastic users.

Number of ...	Quattro Pro 3.0[1]	Lotus 1-2-3 v. 2.3[2]	Lotus 1-2-3 v. 3.1[3]
"Excellent"	7	2	3
"Very Good"	8	4	5
"Good"	0	5	4
"Satisfactory"	2	5	3
"Poor"	0	1	1
Overall score	8.4	6.3	6.5

[1] Source: *InfoWorld*, April 29, 1991. [2] Source: *InfoWorld*, June 10, 1991.
[3] Source: *InfoWorld*, January 28, 1991

REPORT CARD — INFO WORLD

SPREADSHEET SOFTWARE
Quattro Pro
VERSION 3.0

Criterion	(Weighting)	Score
Performance		
Formulas/analysis	(100)	Very Good
Compatibility	(50)	Very Good
Speed	(75)	Very Good
Database	(75)	Excellent
Graphics	(75)	Excellent
Output	(50)	Excellent
Macros	(50)	Very Good
Consolidation/linking	(50)	Excellent
Capacity	(50)	Very Good
Network	(50)	Satisfactory
Documentation	(50)	Excellent
Ease of learning	(50)	Excellent
Ease of use	(75)	Very Good
Error handling	(50)	Very Good
Support		
Support policies	(25)	Very Good
Technical support	(25)	Satisfactory
Value	(100)	Excellent
Final score		**8.4**

We don't blame Lotus for trying to underplay ratings such as these, but clearly Quattro Pro is more powerful. It has better graphics, better capacity, better macros, better consolidation and linking, and much more!

Borland and Quattro Pro: The obvious choice.

Company for company, product for product, the choice is clear. Join more than a million users and upgrade to Borland's Quattro Pro today! If you own any version of Lotus 1-2-3, for only $129⁹⁵ we'll rush you your own copy of the best spreadsheet from the best company.

See your dealer or call 1-800-331-0877 now!

1989 - WINNER - PC Magazine Award for Technical Excellence — APPLICATION SOFTWARE QUATTRO PRO Borland International

PC MAGAZINE EDITORS' CHOICE OCTOBER 1989

PC Computing MVP MOST VALUABLE PRODUCT 1989

1990 BYTE AWARD OF EXCELLENCE

INFO WORLD PRODUCT OF THE YEAR 1990

INFO WORLD BEST IN ITS CLASS Nov. 13, 1989

B O R L A N D

Software Craftsmanship

CODE: MJ64

Circle 26 on Inquiry Card (RESELLERS: 27).

The package has achieved a level of performance that few spreadsheet applications can aspire to. Too bad Borland hasn't released a Macintosh version.

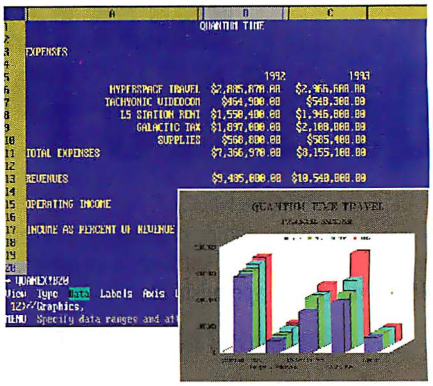
Just as we were wrapping up this BYTE Lab Product Report, Borland sent us a "pre-beta" version of its anticipated Quattro Pro for Windows. Since it's not yet a shipping program, we won't discuss its benchmark performance, but we can talk briefly about its salient features.

Quattro Pro for Windows has a very intuitive user interface that makes it easy to control spreadsheet functions. Context-sensitive Menus-On-Demand give you menu selections for any object on-screen (e.g., a title, page tab, cell, or graph) simply with the click of the right mouse button. The Speedbar provides customizable icons, context-sensitive buttons that automatically change with the function currently being executed; for example, the Graph Speedbar pops up when you are working with graphics. PowerButtons, which you click on to run macros, can be placed anywhere on the screen.

Multiple spreadsheets can be linked into "notebooks." A notebook file can hold up to 256 pages, each of which can be named. Notebook windows can be tiled, stacked, or overlapped, with each page accessible by merely clicking on the notebook tabs.

Borland has maintained the stunning presentation graphics capability that is the trademark of Quattro Pro 3.0 with slide-show functions (including a light table for sorting slides), special effects (e.g., gradient washes and bit-mapped images), and drawing tools. Quattro Pro for Windows can import an incredible eight different graphics file formats, including TIF.

Borland's competitors have their eyes looking out for this project. They should.



CA-SUPERCALC 5.1

FOR DOS

CA-SuperCalc is an example of a perfectly competent spreadsheet program that has fallen by the wayside because it hasn't kept up with its competitors in the race to incorporate presentation features. Still, at $149, SuperCalc delivers substantial spreadsheet power. You can load up to 255 worksheets at one time—provided you have sufficient memory—and perform block calculations across worksheets in true 3-D style. The package also boasts strong statistical features, a minimal recalc option, and an adequate macro language. Despite its strengths, SuperCalc lacks the pizzazz of today's slick WYSIWYG spreadsheets.

The package uses the familiar Lotus 1-2-3 menu structure, but the interface can get confusing at times. The command line builds a command sequence as you make menu choices; for instance, the sequence `//Global,Graphics,Device` shows up on the command line as you select menu options to install a plotter. The command sequence serves no useful purpose and ends up getting in your way. And if you're accustomed to navigating spreadsheets using a mouse, you may be put off by SuperCalc's lack of mouse support.

SuperCalc does, however, let you load multiple spreadsheets into memory and then link them, or you can set up a single spreadsheet file with multiple pages. With a multipage spreadsheet, you can reference cells on a different page by prefacing the cell address (referred to as the named range) with the proper page number. You also can do operations such as sums or averages across pages. These are SuperCalc's strongest features. Ample data analysis functions including matrix operations, frequency distribution, and multiple regression analysis strengthen the package.

When it comes to output capability, SuperCalc has the high-end features you expect, but it simply can't match the

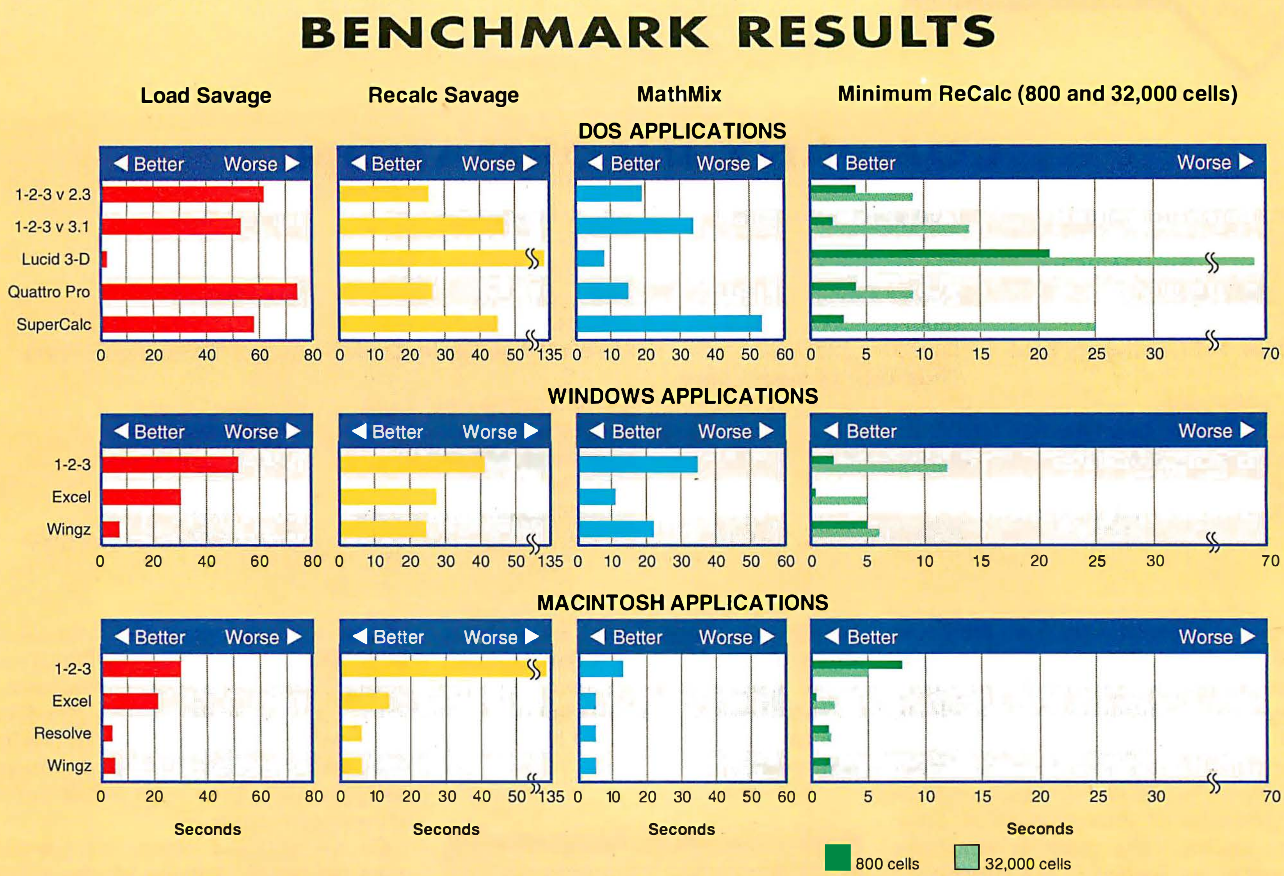
The Benchmarks

Whether or not your primary concern is high-quality graphics, spreadsheet performance always is an issue. With that in mind, we put each of the packages reviewed here through a rigorous series of tests. (See the graphs for results). We benchmarked the DOS and Windows packages on a Compaq 386/20 with 6 MB of memory, a 387 math coprocessor, and an ATI Graphics Accelerator VGA driver (1024 by 768). We ran the DOS programs under DOS 5.0 and the Windows packages in Windows 3.0's Standard mode.

The Macintosh packages were given a workout on an 8 MB Macintosh IIfx running System 7.0. We loaded a 16 KB disk cache and initially turned off virtual memory and 32-bit addressing features. After completing the Macintosh benchmarks, we enabled Virtual Mode and 32-bit addressing. All three Mac programs were run simultaneously with Microsoft Word 4.0. We switched among all the programs randomly and noted when programs were being reloaded from disk. We found no problems with any of the programs running in this mode.

The benchmarks involve slightly modified versions of spreadsheets used in previous BYTE Lab analyses. The Mathmix test recalculates a worksheet of 400 rows by 127 columns. Each cell is the result of a basic math operation (addition, subtraction, multiplication, or division) applied to the first two cells in its column. The result measure a package's speed at performing basic operations. Two tests based on the familiar Savage formula measure performance with floating-point operations and deeply nested formulas. The first, Load Savage, times the loading of a 320-row by 100-column spreadsheet from disk. Recalc Savage measures the time to recalculate that same worksheet.

A test to determine whether a spreadsheet program recalculates all the cells in the worksheet when a change is made, or only the cells affected by the change, rounds out our suite. This test worksheet is a 320-row by 100-column block of simple formulas. All the cells in the worksheet have calculations based on a single key. A second key is linked to only 800 of the cells. If the spreadsheet program performs minimal recalculation, the time differences between changing the two keys is noticeable.



For sheer loading speed, Lucid 3-D (DOS), Wingz (Windows), and Resolve (Macintosh) all take top honors. The Savage Recalc test shows the maximum floating point recalculation speeds are exhibited by 1-2-3 v 2.3 (DOS), Wingz (Windows), and a tie between Resolve and Wingz (Macintosh). The MathMix integer math recalculation test highlights Lucid 3-D (DOS), Excel (Windows), and a three-way tie among Excel, Resolve, and Wingz on the Macintosh.

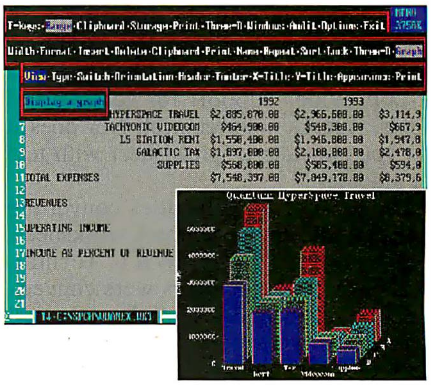
All the spreadsheets, with the exception of Wingz and Resolve, demonstrate their ability to perform minimal recalculations.

aesthetics or flexibility of the graphical spreadsheets such as Wingz and Excel. You can't edit graphics on screen nor place them in your spreadsheet. The program also lacks special annotation features. For the most part, you must build graphs manually, by cycling through various options and filling in the information required. After selecting a graph type, you invoke the Chart Data menu and fill in the ranges for each set of data in your chart. You can do this by simply typing in a range, such as B2:B6, or by pressing a function key and specifying a range using the cursor keys. Another menu option lets you select titles, axis labels, and legends. Formatting control includes color, fonts, point sizes, justification, and more. However, since you have to retreat to the View menu option to look at your results, it can get tedious if, after a few tries, the chart still doesn't look the way you think it should.

Control over publishing features is likewise hampered by the lack of a WYSIWYG interface. Report building follows the same process as graphing. You start by selecting a destination for your report. Then, you define the range from the /Output,Printer,Range menu option, and select output options from the /Output,Printer,Options menu. You have complete control over margins, orientation, spacing, borders, as well as headers and footers. A preview option lets you check the output before you print it.

SuperCalc still is a contender, especially given its low price. However, it seems antiquated when compared against spreadsheets with desktop publishing capability. And its performance does not make up for this shortcoming. It finished dead last on the Mathmix benchmark, a test of basic mathematical calculations.

If you're looking for that special edge when producing reports from a spreadsheet, you won't get it from SuperCalc. At least not right now. Computer Associates International has a Windows version in the works, however. That edition should be more visual and intuitive than the DOS version, and if it's priced as low as SuperCalc, it will find a following as budget-conscious PC users migrate to Windows.



LUCID 3-D 2.5

FOR DOS

Lucid 3-D 2.5 is unique among this crop of spreadsheet programs in that you can use it as a standard DOS program or as a TSR utility. The software comes in three segments: Lucid itself, a file-conversion utility, and a graphing utility. Once you load the graphing and file-conversion utilities into memory, you

COMPANY INFORMATION

Borland International
1800 Green Hills Rd.
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(408) 438-8400
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Circle 1421 on Inquiry Card.

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Circle 1422 on Inquiry Card.

Computer Associates International, Inc.
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Garden City, NY 11530
(800) 645-3003
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Informix Software, Inc.
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(800) 331-1763
fax: (415) 926-6593
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Lotus Development Corp.
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Cambridge, MA 02142
(800) 343-5414
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Lucid Corp.
101 West Renner Rd.
Dallas, TX 75082-2017
(800) 967-5550
fax: (214) 994-8103
Circle 1426 on Inquiry Card.

Microsoft Corp.
1 Microsoft Way
Redmond, WA 98052
(206) 882-8080
fax: (206) 936-7329
Circle 1427 on Inquiry Card.

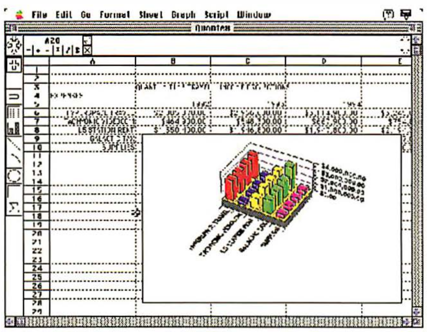
can access them directly from the Lucid 3-D menu. Loading all three components of the package into memory consumes quite a bit of RAM, though. In one sample installation, we saw the number of bytes free plummet from 541,104 after DOS 5.0 was booted to 227,184 after all three program modules were loaded. (The order in which the programs are loaded is not important.) Lucid 3-D also provides the ability to unload the utilities, so you can free up memory when you are not using the product's advanced functions.

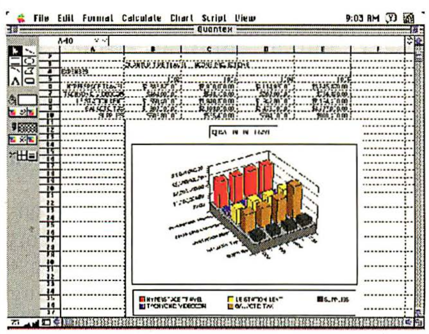
Creating our sample graph was simple: We just selected a range and then selected the Graph menu option. Lucid cannot create embedded graphs; it can only show a separate full-screen chart. It does, however, provide support for all common chart types: bar, line, 3-D, pie, area, scatter, and so on. Although Lucid 3-D provides support for scaling and fonts, it lacks color control. Nor does it let you annotate a spreadsheet with text or graphics.

Lucid 3-D had difficulties converting our example and benchmark worksheets from Lotus 1-2-3 WK1 format. Although all the numbers were converted, simple formulas and absolute cell references were not. We had to enter each of these in our worksheets manually. Lucid was the only spreadsheet we tested that had this difficulty. The single user's manual that comes with the package provided no clue to why we couldn't satisfactorily load and convert our WK1 worksheets.

Besides being a TSR, Lucid can lay claim to being one of the earliest spreadsheets to support 3-D linking. Although we are not focusing on this capability in here, it is an unusual feature to find in such an inexpensive program.

If you are looking for a presentation-quality spreadsheet, Lucid 3-D is not a strong choice. However, if you typically work with small- to medium-size spreadsheets and need 3-D linking, then it is hard to beat Lucid 3-D for cost and performance.





WINGZ 1.1A AND RESOLVE

FOR THE MACINTOSH

Informix's Wingz presents a uniform user interface across several platforms: Macintosh, Microsoft Windows, OS/2 Presentation Manager, and OSF/Motif and OpenLook under Unix. It also offers a uniform scripting language that you can link to user-defined buttons and text fields. There is another interesting wrinkle, as well: Informix has licensed its basic Wingz product for the Macintosh to Claris Corp., which has incorporated it into a spreadsheet called Resolve. Because Resolve, Wingz for the Macintosh, and Wingz for Windows are essentially the same product, it is difficult to review them separately.

On any platform, Wingz is a consummate performer: Both the Macintosh and Windows versions were significantly faster than the competition for most operations. Unfortunately, however, Wingz does not perform minimal recalculation; it always recalculates the entire spreadsheet. Consequently, the other packages did better when only portions of spreadsheets required recalculation.

Although Wingz presents a uniform interface on all platforms, the Macintosh and Windows versions provide sufficient subtle changes to make each conform to the conventions of its environment. The one area for which this is not true is interactive help. Wingz provides a proprietary help system, and although this system is easy to use, it doesn't work as you'd initially expect a Macintosh or Windows help system to work. Of course, the up side to this is that folks who use Wingz on both platforms will have the pleasure of working with a consistent help system.

Wingz is a tried-and-true performer on the Macintosh. Although Informix hasn't updated the program since 1989, our experience indicates that this isn't a shortcoming: Nothing needs fixing. The package contains two spreadsheet versions: The first is a general 68000-based version; the other is optimized for the 68020. The 68020-specific version of Wingz ran flawlessly under System 7.0, even with full 32-bit addressing and virtual memory active. That qualifies it as System 7.0-compatible, but, as an older

program, it is not 7.0-aware. If you like Wingz but require System 7.0 features such as Publish and Subscribe, you should probably look at Resolve—Wingz' computational engine hooked to an updated interface—or Excel or the new Lotus 1-2-3 for Macintosh.

System 7.0-aware Resolve provides support for such advanced features as Publish and Subscribe and Bubble Help. Our benchmarks show that Resolve's throughput is comparable to Wingz', although Wingz always manages to win by a hair. Our decision to evaluate the 68020-specific version of Wingz may account for the slight speed difference.

One unique feature the three packages share is a pop-up window that appears when you move the scroll bars to navigate the spreadsheet. This window displays your position in the spreadsheet as you move the thumb of the scroll bar. If you frequently work with large spreadsheets, this feature alone makes any of the three programs worth the investment.

Generating the sample 3-D chart was slightly more intuitive in Resolve than in Wingz. That's because Claris has reduced the amount of information on the screen by eliminating some icons from the icon palette and replacing them with menu commands. Differences also exist in regard to charting procedures, though these are largely superficial. Resolve displays the chart as soon as you select the Make Chart menu item. Wingz, on the other hand, requires you to select a location and size before you can display a chart. All three packages let you move and resize charts, however. Initial chart generation takes seconds, but you probably will spend 10 or 20 minutes fine-tuning the location of headings, labels, and ancillary text.

Drawing and labeling tools are available for annotating a chart with text, circles, boxes, lines, and arcs. However, you must use the Group option to associate the annotations with the chart. Otherwise, the added text and graphics will stay behind when you move the chart.

The three products support approximately two dozen chart styles, ranging from simple bar charts to sophisticated contour and polar graphs. Limited color support is provided; you can change the grid and base colors but do not have any control over the color of individual bars.

In addition to simple graphics and text annotation, Resolve and Wingz offer the ability to embed familiar control objects such as buttons, boxes containing text, and dialog boxes in a worksheet. Buttons allow you to construct an interactive interface to your spreadsheet. You may draw buttons anywhere on the spreadsheet and attach them to scripts. Dialog boxes may be used to retrieve information, which you then can incorporate into the spreadsheet. You may designate text boxes as locked or permit editing of the text, and you can do search and replace, check spelling, or add a scroll bar so that you can move around a text box more quickly. All these features taken together mean that you can create an interactive interface through which the user enters data and receives results, while the spreadsheet doing the calculations remains hidden from view.

The programs' HyperCard-style scripting language, in addition to offering standard calculation and program control functions, can respond to events such as mouse clicks and movement, the opening of a new spreadsheet or the

changing of an old one, and spreadsheet recalculation. One of the scripts included in the packages, for example, shows how to update a spreadsheet cell while the processor is idle. Other scripting features include the ability to create dialog boxes, respond to dialog boxes, and create new menu items.

Another of Wingz' helpful functions is its ability to call external functions written in languages such as C or Pascal. This allows Wingz to perform specialized, complex calculations and even interface with hardware data-acquisition systems.

Resolve requires 2 MB of disk space for a basic installation and 5 MB with examples. Wingz requires approximately 2 MB for a basic installation and another 630 KB for the program's tutorial and samples.

Calculate Summary

In the DOS world, picking a spreadsheet has become a tough call. Quattro Pro and Lotus 1-2-3 release 2.3 are extraordinary packages; they do things on low-end machines with limited memory that most other software companies only dream of. Both are highly graphical programs that prove you don't need a full-blown GUI to look good.

In the Windows realm, Excel, Lotus 1-2-3, and Wingz all take full advantage of the graphical environment and present you with an intuitive, attractive interface that masks complex operations. Wingz is appropriately named; when put to the test, it soars past Excel and Lotus 1-2-3. All three are strong contenders if you need a spreadsheet with one foot in the Windows environment and another in the Macintosh world.

In the Macintosh environment, Claris's Resolve is a hands-down winner for general performance and presentation capabilities. Its ease of use, price, and support for System 7.0–specific features put it ahead of the pack. Microsoft Excel simply cannot be beaten for features. If you need all the bells and whistles, access to external databases, and the ability to solve multivariable problems, then Excel is a must-have. The prize for the most graphical functions as well as the best performance goes to Wingz, an excellent product with a steep learning curve. Wingz also merits consideration for its ability to run on Macs and Windows systems. Lotus 1-2-3 is the spreadsheet to have if you work in a shop that's committed to 1-2-3 on DOS machines but also has Macs; its cross-platform capabilities, particularly its file sharing prowess, gives it a significant edge.

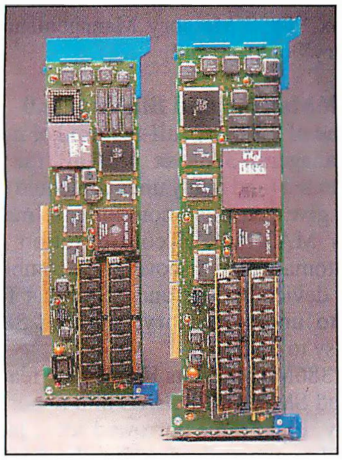
While the competition in the spreadsheet market has resulted in better programs, it makes buying recommendations and decisions much more difficult. Gone are the days when you could just walk in and say, "Give me Lotus." Picking the right spreadsheet program is no longer as easy as 1-2-3. ■

BYTE Lab editor Raymond GA Côté is continuing his 15-year love affair with computers as tools and toys. He has extensive experience as a software developer and designer of interpretive languages and user interfaces. David L. Edwards is a consulting editor for the BYTE Lab. You can reach them on BIX as "rgacote" and "dedwards," respectively.

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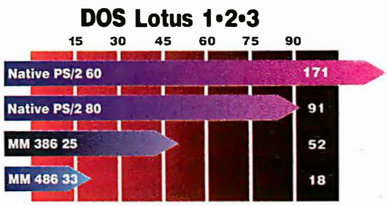


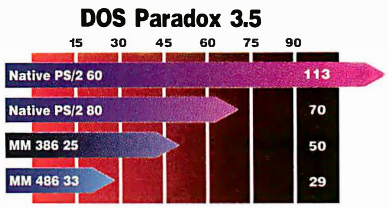
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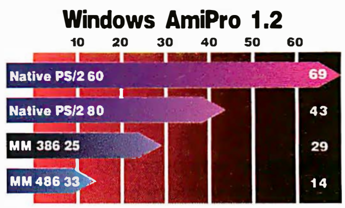
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SOFTWARE

Raising the Ceiling: Nine Memory Managers for Today's Processors

BARRY NANCE

The PCs of today are generally burdened with stacks of TSR utilities, drivers for nonstandard devices, and links to other systems through network software. These all take up memory, and, traditionally, they're shoehorned into that 10-year-old bugaboo, the 640-KB DOS application area.

New processors bring the ability to address more than the 8088's 1 MB of memory, along with silicon for *managing* that extra memory. As a result, you can move around blocks of memory in the address space so that they can appear anywhere, in any order. By deftly moving memory around, it's possible to move TSRs, drivers, and other resident software out of the 640-KB space, freeing more memory for DOS applications.

In this review, I'll examine nine utilities that tap into the memory management features of 286, 386, and 486 processors, and some specialized memory management chips, to give DOS applications more room. In addition, I found two inexpensive shareware memory managers that may be just right for you (see the text box "The Shareware Side" on page 244). If you're running DOS on a late-model PC that has some extra memory, you should probably use one of these programs.

BYTE ACTION SUMMARY

- **WHAT DOS MEMORY MANAGERS DO**
  Memory managers use the advanced capabilities of late-model Intel CPUs to make more memory available to DOS applications.
- **LIKES**
  You often wind up with over 620 KB of conventional memory by using one of these products, even with bulky LAN drivers installed.
- **DISLIKES**
  Memory managers can be difficult to configure.
- **RECOMMENDATIONS**
  Use 386Max (or BlueMax, if you have a PS/2).

The Test-Bed

The nine memory managers I put under the microscope are 386Max 6.0 and BlueMax 6.0 from Qualitas, QEMM-386 6.0 from Quarterdeck Office Systems, Dynamic Memory Control 3.0 from Adlersparre & Associates, Memory Commander 2.11 from V Communications, Maximizer 3.3 from SoftNet Communication, NetRoom 2.01 from Helix Software, and QMAPS 2.0 and UMB Pro 2.0 from Quadtel.

To test these products, I used several computers in a variety of configurations. Two notebook computers took part: a Bitwise Designs 33-MHz 386 and CompuAdd's Companion SX, a 20-MHz 386SX. Both had 4 MB of RAM and ran DOS 5.0. The desktop units in the test were a Gateway 2000 386/33 with 16 MB of RAM, an IBM PS/2 Model 70 with 6 MB of RAM, and an IBM PS/2 Model 80 with 5 MB of RAM. I put all the machines on a NetWare LAN. I used Xircom Pocket Token Ring adapters with Xircom's SMARTIPX.EXE on the Bitwise and CompuAdd notebook systems; SMARTIPX is 192 KB but whittles itself down to 9 KB of resident code—a good test for these memory managers.

If you're not familiar with the standards, acronyms, and buzzwords associated with DOS memory managers, you'll want to scan the definitions in the text box "DOS Memory Management Glossary" on page 242.

386Max 6.0 and BlueMax 6.0

One of the most full-featured of memory managers, 386Max uses all the documented (and many undocumented) tricks to give you more conventional memory. Its MAXIMIZE configuration utility automatically discovers the combination of device drivers and TSRs that fit best into upper memory, making 386Max easy to install.

386Max used its FlexFrame feature to load SMARTIPX.EXE into upper memory. FlexFrame borrowed some memory and temporarily disabled the EMS page frame to load the 192-KB executable file. Once SMARTIPX shrank to its 9-KB resident size, 386Max returned the unused memory to its previous state. DOS 5.0 by itself couldn't load SMARTIPX into upper memory.

Included with 386Max is ASQ, a computer configuration and memory-usage analysis program. You can use ASQ if you're curious about your computer; you don't need it for the normal operation of 386Max.

Of the utilities I evaluated, 386Max provides the most types of interfaces to expanded and extended memory. With 386Max, you get support for EMS 4.0, Extended Memory Specification (XMS), Virtual Control Program Interface (VCPI), DOS Protected Mode Interface (DPMI), and Virtual Direct Memory

DOS MEMORY MANAGER FEATURES

Of the 11 memory managers tested, only three—386Max, BlueMax, and QEMM-386—can have TSRs larger than available memory and automatically allocate TSRs. (● = yes; ○ = no; N/A = not applicable; NS = no support.)

	386Max 6.0	BlueMax 6.0	QEMM-386 6.0	Dynamic Memory Control 3.0	Memory Commander 2.11	Maximizer 3.3	NetRoom 2.01	QMAPS 2.0	UMB Pro 2.0	CTMAP 0.98	VRAM/386 and HRAM 1.0
Price	$130	$155	$99.95	$79.95	$99.95	$49.95	$99	$129.95	$89.95	$30	$35
Works with DOS 5.0	●	●	●	●	●	●	●	●	●	●	●
Works with Windows	●	●	●	●	●	●	●	●	●	●	●
Can instance TSRs	●	●	○	○	●	●	○	○	○	○	○
Minimum RAM required	1 KB	1 KB	2KB	22 KB	3 KB	64 KB	4 KB	2 KB	8 KB	0 KB	15 KB
Maximum RAM manageable											
EMS	32 MB	32 MB	>32 MB	N/A	15 MB	NS	32 MB	32 MB	NS	NS	32 MB
XMS	4 GB	4 GB	64 MB	N/A	15 MB	NS	32 MB	64 MB	NS	NS	32 MB
Drivers and TSRs in upper memory	●	●	●	N/A	●	●	●	●	●	●	●
TSRs larger than available memory	●	●	●	○	○	○	○	○	○	○	○
Unloads drivers, TSRs	○	○	○	●	○	○	○	○	○	○	○
Automatic TSR allocation	●	●	●	N/A	○	○	○	○	○	○	○
Memory mapper software	●	●	●	●	●	●	●	●	●	○	●
CPU types	1, 2	1, 2	1, 2	Any	1	1, 2	1, 2	1	1, 2	2	1

1 = 386, 486
2 = Chips & Technologies 82C212 NEAT, 82C235 SCAT, or 82C302 or 82C307 Chipset DRAM controller.

Access Services (VDS). In addition, 386Max supports the instancing of TSRs in DOS sessions under 386 enhanced-mode Windows. Instancing lets you run multiple copies of a TSR or driver in different DOS sessions.

If you have a 386-based IBM PS/2, IBM supplied you with extra ROM BIOS code that can operate in protected mode. Under DOS, you don't need it. A separate Qualitas product, BlueMax, is a special version of 386Max that remaps the ROM BIOS memory and gives you another 84 KB of upper memory.

QEMM-386 6.0

QEMM-386 is another full-featured memory manager. Its OPTIMIZE function automatically analyzes your computer's configuration and memory and tells QEMM-386 where best to put your device drivers and TSRs. If you have 10 TSRs and device drivers of varying sizes and want to configure by hand, you'll find there are 3,628,800 combinations to try. Better let OPTIMIZE do the work.

The dynamic management scheme that 386Max calls FlexFrame has a QEMM-386 equivalent named Squeeze. Squeeze allows QEMM-386, like 386-Max, to bring honor to itself by loading the 192-KB SMARTIPX TSR into upper memory.

QEMM's computer and memory analysis software, MANIFEST, is more complete than ASQ. As with ASQ, you probably won't need MANIFEST in the normal course of operating QEMM.

QEMM provides EMS, XMS, VCPI, and VDS support, although not DPMI. QEMM can also remap ROM BIOS memory with what it calls Stealth technology. On a PS/2 with no network card installed, QEMM typically gives you an extra 96 KB of upper memory; on a Compaq 20e, it can give you 136 KB of upper memory to use.

QEMM is compatible with Windows 3.x, but it can't instance TSRs in a DOS session. Like 386Max, QEMM specially recognizes NEAT or SCAT chip sets from Chips & Technologies and makes use of their unique memory management functions.

Dynamic Memory Control 3.0

Dynamic Memory Control (DMC) is an add-on for products like QEMM and 386Max, not a competitor. With DMC, you can unload device drivers and TSRs from memory and then load new ones without rebooting.

You can use DMC on device drivers and TSRs loaded in conventional memory as well as upper memory. You may already be familiar with the public domain MARK/RELEASE utilities, which became popular when people first began using TSRs. DMC goes several steps further, letting you manage TSRs in upper memory and letting you load and unload device drivers from the DOS command line. I used DMC to unload IBM's LAN Support Program device drivers and replace them with Locus Computing's PC Interface device drivers so that I could switch from NetWare to PC Interface on a Token Ring LAN without rebooting.

Memory Commander 2.11

Other memory managers can provide more than 640 KB of conventional DOS memory—up to over 700 KB worth—but Memory Commander goes further. Depending on your computer's configuration, Memory Commander can give you up to 952 KB of conventional memory in which to run DOS applications. But the catches are numerous: You must use a monochrome display adapter, you can't

DOS Memory Management Glossary

conventional memory The memory that's directly addressable by an Intel CPU in real mode. The upper boundary is normally the infamous 640-KB limit, but some memory managers raise that.

DOS Protected Mode Interface (DPMI) Developed by Microsoft, DPMI offers functions similar to VCPI but enforces control over extended memory access.

expanded memory Invented jointly by Lotus, Intel, and Microsoft, expanded memory lets an application bank-switch RAM, in 16-KB blocks, from an Expanded Memory Specification memory card into conventional or upper memory. Version 4.0 of EMS is the most recent. On 386 and 486 machines, memory managers can transform extended memory into expanded memory.

extended memory Memory that is above the 1-MB threshold, addressable only in protected mode.

Extended Memory Specification (XMS) Also developed by Lotus, Intel, and Microsoft, this standard provides a rudimentary means for DOS applications to use portions of extended memory.

high memory area (HMA) The first 64 KB of extended memory, minus 16 bytes, beginning at the 1-MB threshold. Through a quirk in the design of the 286, 386, and 486 CPU chips, it is possible to address these 65,520 bytes in real mode.

upper memory The memory between 640 KB and 1 MB. Video adapters, ROM BIOS chips, hard drive controller ROMs, and network adapters live in this region, but there are "holes"—upper memory blocks—that some memory managers can map as conventional memory.

Virtual Control Program Interface (VCPI) memory Quarterdeck Office Systems and Phar Lap Software developed the VCPI standard to let DOS applications cooperatively share extended memory without conflict.

Virtual Direct Memory Access Services (VDS) Another Microsoft standard, VDS lets a memory manager and a computer's hardware components share the use of the DMA controller.

load a lot of TSRs and device drivers into upper memory, you can't access EMS memory, you can't use Windows, and you can't have an adapter card whose memory address overlaps the 952-KB area. If you can live with these restrictions, then you can have 952 KB of conventional memory. On a VGA-equipped computer, you can get up to 920 KB if you don't use graphical applications, and up to 800 KB if you do use graphics.

Memory Commander shifts and remaps video display adapter memory, on the fly, as you use your computer. This memory is normally located just above the 640-KB boundary. Memory Commander maintains a list of applications internally, so it knows which video mode is appropriate for an application.

Besides offering more conventional memory, Memory Commander has many of the same features as the other memory managers. It supports EMS 4.0, XMS, VCPI, and VDS; it loads device drivers and TSRs into upper memory; and it can instance TSRs within a Windows 3.x DOS session. However, Memory Commander was unable to load SMARTIPX into upper memory.

Maximizer 3.3

If all you want to do is manage upper memory, and if you don't mind a little manual effort to help Maximizer find and use upper memory blocks, Maximizer is a less expensive alternative to the other memory manager products. During installation, you give Maximizer commands (op codes) to tell it which areas in upper memory to use.

Maximizer can load device drivers and TSRs into upper memory, and it can make more than 640 KB available to your DOS applications. It couldn't load SMARTIPX into upper memory, and it won't give you EMS 4.0, XMS, VCPI, VDS, or DPMI memory. But it works with Windows and DOS 5.0, and it lets you instance device drivers and TSRs within an enhanced-mode DOS session.

NetRoom 2.01

Its name suggests that it works only on LANs. Actually, you can use NetRoom just like the other 386-based memory managers to load even nonnetwork drivers and TSRs into high memory. NetRoom uses the special capabilities of the 386 CPU chip to remap upper memory and to provide EMS 4.0 and XMS support. It does not, however, offer VCPI, VDS, or DPMI support. It, too, failed to load SMARTIPX into upper memory.

The installation procedure is somewhat more automatic than Maximizer's, but it is not nearly as easy to use or as transparent as that of QEMM-386 or 386Max. NetRoom's DISCOVER program includes a text editor for making modifications to your CONFIG.SYS and AUTOEXEC.BAT files.

NetRoom's strength is the extent to which the documentation describes how to set up NetRoom for particular LAN environments, including NetWare, Banyan Vines, LAN Manager, 3Com+, PC LAN Program, and LANtastic. Like 386Max and QEMM, NetRoom specially recognizes Chips & Technologies' NEAT or SCAT chip sets and makes use of their memory management functions.

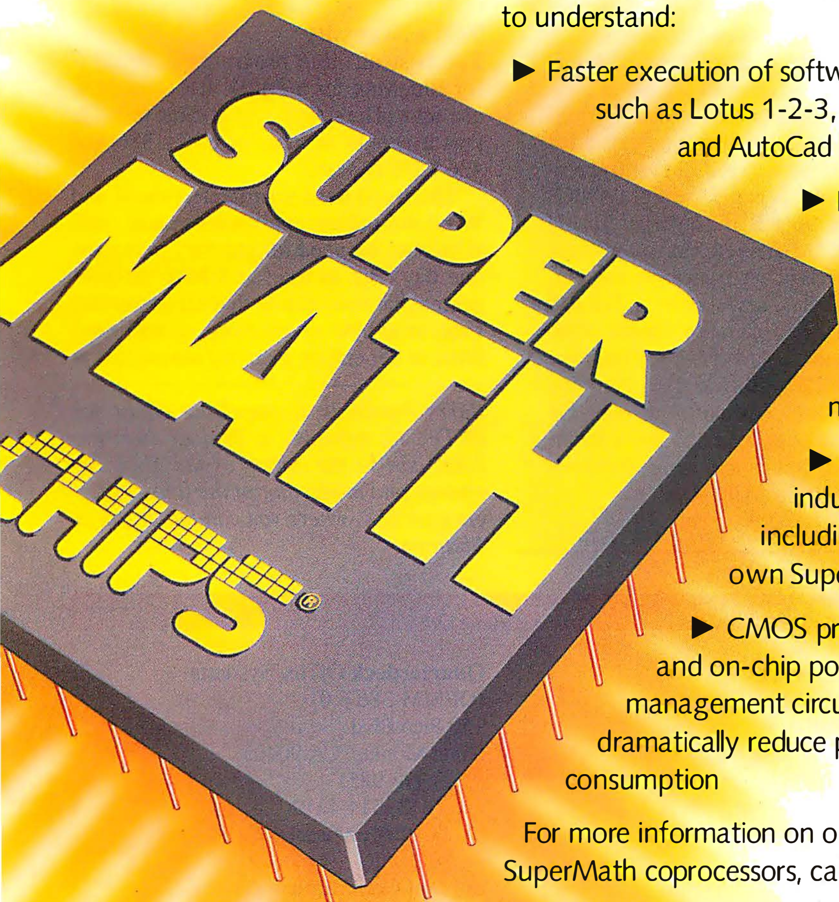
QMAPS 2.0 and UMB Pro 2.0

QMAPS stands for Quadtel Memory Allocation and Paging System; UMB Pro refers, of course, to Upper Memory Blocks. QMAPS is an EMS 4.0 memory manager that uses EMS to load device drivers and TSRs into upper memory.

QMAPS isn't as full-featured as 386Max or QEMM, but it supports more memory specifications than NetRoom or Maximizer: EMS 4.0, XMS, VCPI, and VDS. QMAPS cannot instance device drivers or TSRs within a Windows DOS session, but it is compatible with Windows 3.x and DOS 5.0.

Installing QMAPS is not quite as "hands-on" an operation as installing

When You Think 387, Think Faster.



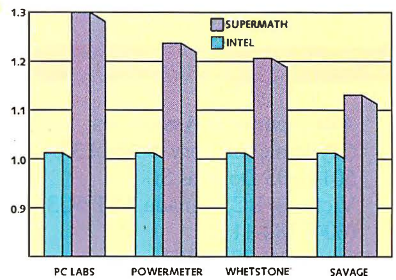
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The Shareware Side

CTMAP 0.98 from Burton Systems Software is a shareware memory manager for computers using a Chips & Technologies chip set. At only $30, it's a steal.

If you are using a 286, 386, or 386SX computer that includes a Chips & Technologies 82C212 NEAT chip set, an 82C235 SCAT chip, or an 82C302 or 82C307 Chipset DRAM controller chip, CTMAP knows how to rearrange and manage memory so you get up to 944 KB of conventional memory. If you have EGA or VGA but don't use graphics, CTMAP extends the 640-KB ceiling upward to 704 KB or 736 KB. By mapping up to 240 KB of discontinuous upper memory space, CTMAP lets DOS have even more memory. However, some software can't use discontinuous RAM.

The CTMAP memory manager doesn't put the CPU in protected mode, and it doesn't install a TSR program or device driver, which makes it highly compatible with protected-mode software. It even works in the DOS boxes of versions 1.2 and 1.3 of OS/2.

VRAM/386 and HRAM 1.0

Beginning with version 1.05, Biologic turned VRAM/386 and the companion HRAM into a commercial product. Still, the shareware version 1.0 is quite capable and reasonably priced at $35.

VRAM/386 uses the same memory-mapping techniques as the other 386-based products in this review. It converts extended memory into expanded memory, following the EMS 4.0 specification, and it can raise the 640-KB ceiling by 96 KB if you're not using VGA. VRAM and HRAM can manage up to 208 KB of upper memory for relocating TSRs and device drivers. HRAM manages upper memory blocks. One drawback to VRAM is that you must use its CHKMEM utility to find out what blocks of upper memory are available and manually tell VRAM about them. VRAM is compatible with Windows and supports the VCPI standard.

Maximizer, but you will need to figure out where you want to put things in memory. A menu-driven configuration utility will help you. And QMAPS offers up to 28 standard configurations from which you can select at installation time.

UMB Pro, also from Quadtel, is much like Maximizer—it manages upper memory blocks so you can load drivers and TSRs high, but it doesn't give you EMS 4.0, XMS, VCPI, VDS, or DPMI memory. However, it does work with Windows 3.x and DOS 5.0. Neither QMAPS nor UMB Pro managed to load SMART-IPX into upper memory.

Still a Necessity

The best of these programs is 386Max (or BlueMax for a PS/2). It's so easy to use and offers such significant benefits that it should be part of every 386 and 486 DOS system.

The trend toward protected-mode and Windows-native applications may well eliminate the need for memory managers one day. But as long as I have pet programs that *must* run in that all-important first megabyte of memory, I will continue to depend on memory managers. ■

Barry Nance is a consulting editor for BYTE. He manages a 70-node NetWare LAN and is the editor of the IBM Exchange and moderator of the lans conference on BIX, where you can reach him as "barryn."

COMPANY INFORMATION

Adlersparre & Associates
(Dynamic Memory Control 3.0)
501-1803 Douglas St.
Victoria, BC, Canada V8T 5C3
(604) 384-1118
fax: (604) 384-3363
Circle 1231 on Inquiry Card.

Biologic Corp.
(VRAM/386 and HRAM 1.0)
P.O. Box 1267
Manassas, VA 22110
(703) 368-2949
fax: (703) 361-8251
Circle 1232 on Inquiry Card.

Burton Systems Software, Inc.
(CTMAP 0.98)
P.O. Box 4156
Cary, NC 27519
(919) 233-8128
fax: (919) 233-0716
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Helix Software
(NetRoom 2.01)
47-09 30th St.
Long Island City, NY 11101
(800) 451-0551
fax: (718) 392-4212
Circle 1234 on Inquiry Card.

Quadtel Corp.
(QMAPS 2.0, UMB Pro 2.0)
3190-J Airport Loop Dr.
Costa Mesa, CA 92626
(714) 754-4422
fax: (714) 754-4426
Circle 1235 on Inquiry Card.

Qualitas, Inc.
(386Max 6.0, BlueMax 6.0)
7101 Wisconsin Ave., Suite 1386
Bethesda, MD 20814
(800) 733-1377
(301) 907-6700
fax: (301) 907-0905
Circle 1236 on Inquiry Card.

Quarterdeck Office Systems
(QEMM-386 6.0)
150 Pico Blvd.
Santa Monica, CA 90405
(213) 392-9851
fax: (213) 314-4219
Circle 1237 on Inquiry Card.

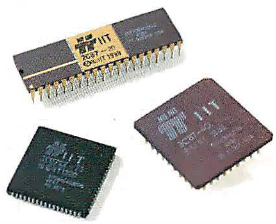
SoftNet Communication, Inc.
(Maximizer 3.3)
11 Hillcrest Dr.
Great Neck, NY 11021
(212) 956-2390
Circle 1238 on Inquiry Card.

V Communications
(Memory Commander 2.11)
4320 Stevens Creek Blvd.,
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SOFTWARE

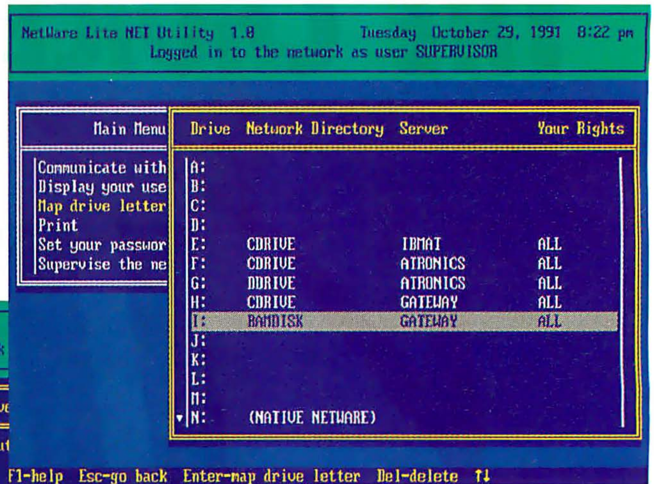
NetWare Grows Lean, Not Mean

BARRY NANCE

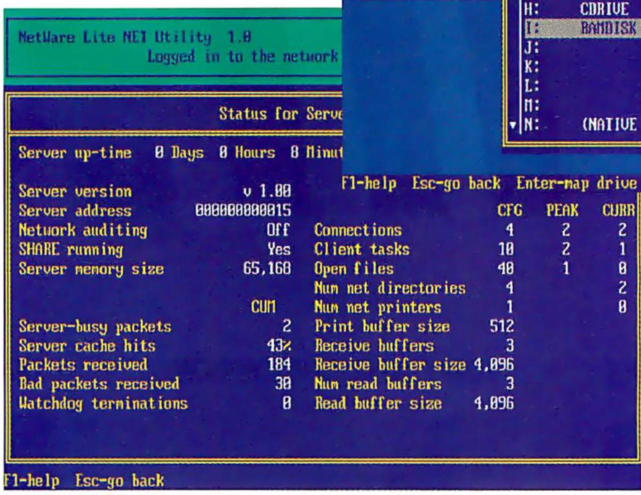
While Novell's NetWare and Microsoft's LAN Manager slugged it out for dominance on the network-operating-system high ground, the peer LAN arena heated up with a competition of its own. The result was a group of tailored products that suit small workgroups for whom server-based NetWare is too expensive.

Recently, Novell introduced its own peer-to-peer LAN operating system, NetWare Lite. Like most other peer LAN products, NetWare Lite is DOS-based, so you don't need to purchase a separate computer to act as a file server. Smaller workgroups can cost-justify a NetWare Lite LAN ($99 per node for the software) in situations where NetWare 2.2 ($895 for five users, $1995 for 10 users—not to mention the cost of a file server) is not in the budget.

Last November, I reviewed five peer-to-peer LANs ("Peer LANs Offer a Low-Cost Network Alternative," November 1991 BYTE). Just about the time that issue hit the newsstands, Novell began selling NetWare Lite. This month I put NetWare Lite 1.0 through the same paces as the other products, using the same criteria: reliability, ease of use, price, security, features, and performance.



Screen 1: *A NetWare Lite menu option displays drive mappings. Here, drives E through I are Lite drives, while drive N is a NetWare 3.11 file server.*



Screen 2: *The Lite server status screen bears a strong resemblance to a NetWare 3.11 "Monitor" screen.*

Network Trials

I ran a set of LAN-based test suites to determine NetWare Lite's reliability, application compatibility, performance, and peer-to-peer communications capability. The reliability test concurrently copies 1000 files totaling 15 MB between several machines to test for file errors under load. NetWare Lite passed this test without incident. As with the other peer LAN products, you can trust Lite with your data.

The compatibility suite checks for LAN-operating-system compliance with DOS file-sharing conventions. All DOS applications issue DOS function calls to perform LAN file I/O. Certain functions (e.g., create file, change directory, and delete file) should behave exactly the same on a LAN as they do on a local disk. Other functions (e.g., open file, read file, write file, and lock record) operate differently on a file server so that multiple users of an application can share, or not share, files as necessary.

As I mentioned in November, a LAN operating system that passes these tests implements the specifications correctly, and it should work fine with Paradox, dBase, FoxPro, WordPerfect Office, and other DOS-based applications. NetWare Lite passed the DOS file-sharing test suite but didn't achieve a perfect score. I found that two workstations that attempted to open the same file in compatibility mode (as described in the IBM *DOS Technical Reference*) were both able to open the same file under NetWare Lite. With the other peer LAN products, as with server-based NetWare 2.2 and 3.11, the second workstation's open attempt failed, as it should. The error is a small one, and it probably won't affect your applications if you buy NetWare Lite.

The performance suite determines the LAN operating system's network file I/O performance by reading and writing files of random sizes. PowerLAN won the race last November; it proved itself a second time by outdistancing NetWare Lite (see the benchmark graph). For this test, I used a LAN whose topology is based on Thomas Conrad's 100-Mbps fiber optics–based TCNS, with 33-MHz 486 ALR PowerPro and 33-MHz 386 Gateway 2000 computers as peer servers/workstations. Certainly, with 100-Mbps fiber optics and fast workstations such as these, the hardware was not a limiting factor.

I set up a 32-KB RAM cache with DOS 5.0's SMARTDRV.SYS, and I rebooted all the computers prior to each test. I asked a Novell spokesperson why NetWare Lite was slower, and he told me that it's designed for simple operation and ease of use, not speed. Fair enough.

The final suite tests PC-to-PC communications using both NetBIOS and IPX programming techniques. Third-party LAN utilities, remote control, and some E-mail packages use these protocols to talk PC-to-PC. NetWare Lite passed the tests in this category with fly-

ing colors, and it is the only peer LAN operating system that provides *both* IPX and NetBIOS protocols.

Easy to Install

Easy installation, ease of use, and simplicity are NetWare Lite's hallmarks. The manual gets high marks for readability. I would almost suggest that you get a copy of NetWare Lite just to read the manual—it's the best introduction to networks I've ever seen. The manual uses a series of railroad metaphors to explain LAN basics, making difficult concepts clear with its illustrations. The on-line help facility is similarly clear and comprehensive.

You share directories and printers on each designated server with simple commands or with NetWare Lite's menuing system (see screens 1 and 2). The menus are clear, direct, and virtually foolproof. NetWare Lite is compatible with Microsoft Windows, although you must specify "no network" or "MS/Network compatible" instead of the usual "NetWare network" setup option.

NetWare Lite interoperates with its bigger brothers, NetWare 2.2 and 3.11. You simply run NETx.COM in addition to the NetWare Lite software and then log into the server as usual. NetWare Lite comes with Open Data Link Interface drivers for a variety of network adapters, and it works with any adapter that supplies an ODI driver.

NetWare Lite supports up to 25 users, somewhat less than other peer LAN products. There is no technical reason it couldn't support more users, but Novell probably prefers that you'll switch to regular NetWare when your LAN grows to 25 users. NetWare Lite will not recognize an uninterruptible power supply. It can, if you wish, let you share a CD-ROM drive across the network. NetWare Lite does not support remote boot; each workstation must have a floppy or hard drive from which to run the software.

If you press Ctrl-Alt-Del at a server, NetWare Lite asks you if you are sure you want to reboot the computer. If you go ahead and reboot the server, workstations can reconnect, but only by answering "Retry" to the DOS "Abort, Retry, Ignore?" message. When I asked Novell about this, a spokesperson said that the company would think about making the reconnection process friendlier and more automatic in a future release.

Printing to a shared printer is easy with NetWare Lite. At a workstation, you use a NET CAPTURE command much like the one you'd use with regular NetWare to redirect printouts to a remote printer. You can specify whether you want a banner page (job separator page) printed, the number of copies to print, whether a formfeed should automatically be inserted into the print stream by NetWare Lite, the amount of idle time NetWare Lite should use to detect the end of the print operation (in case the application doesn't actually close the LPTx device when it's done printing), the setup string NetWare Lite should use as a prefix to the print material, and other print parameters. You can view and change the print queue; NetWare Lite displays job number, user, job name, and job status

BYTE ACTION SUMMARY

WHAT NETWARE LITE DOES
NetWare Lite lets PCs share each other's hard disks and printers as equals, without your having to use a separate file server.

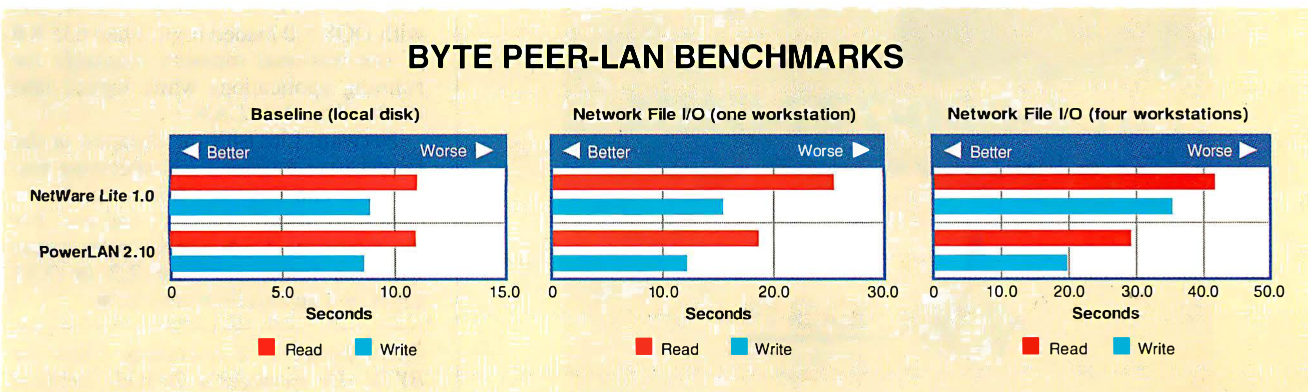
LIKES
NetWare Lite is the easiest peer LAN to install, use, and manage. It operates well by itself or as part of a larger NetWare 2.2 or 3.11 LAN.

DISLIKES
Performance will become an issue as your LAN grows. Reconnecting to a rebooted server isn't automatic.

RECOMMENDATIONS
If you're new to networking, or want to have a peer LAN within a larger NetWare LAN, get NetWare Lite.

PRICE
$99 per node

FOR MORE INFORMATION
Novell, Inc.
122 East 1700 South
Provo, UT 84606
(800) 346-7177
(801) 429-5900
Circle 1225 on Inquiry Card.



NetWare Lite is fast, but not fastest. PowerLAN, the fastest peer LAN BYTE has tested, outran NetWare Lite on our tests. NetWare Lite's score of about two-thirds the speed of PowerLAN makes it about average among peer LANs we benchmarked in November.

so you can check on your printout.

Your data is as secure with NetWare Lite as with regular NetWare. For each user, you can enable/disable the account, grant or revoke supervisor (management) privileges, require passwords, set the minimum number of characters and expiration date of the password, and of course delete accounts. For each directory, you can specify default access rights and single out those users who should have nondefault access rights.

NetWare Lite is copy-protected, but there are no laser holes burned into the distribution disks. Instead, when you start NetWare Lite at a workstation, it communicates with the other workstations to see if that same instance of the software is already running at another workstation. If software has to be copy protected, this is the way to do it—a network-based scheme is the least intrusive and easiest to administer.

For technical support, Novell offers several options. You can fax your inquiries to Novell, use the NetWire forum on CompuServe, ask your dealer to answer your questions, or use Novell's new 900 support number.

Less Filling...

Novell programmers tried to make NetWare Lite take up as little memory as possible. I found that the various NetWare Lite modules took a total of 96.8 KB on a server machine: 13.8 KB of adapter support software (including IPX), 13 KB of client software, 63 KB of server software, and 6 KB of SHARE .EXE. On a nonpeer, client-only workstation, NetWare Lite uses only 26.8 KB of RAM.

DOS 5.0 by itself can load all but the server module into high RAM. QEMM or 386Max can load all the modules, including the server code, into high RAM on a 386 computer. Using QEMM, and with DOS 5.0 loaded high, I had 635 KB of conventional memory available for running applications while logged into the NetWare Lite LAN.

NetWare Lite isn't the cheapest or the fastest peer-to-peer LAN operating system you can buy. But it's certainly the easiest to install, manage, and use. For the first-time LAN, or for peer access within a larger NetWare 2.2 or 3.11 LAN, it's an excellent choice. ■

Barry Nance is a consulting editor for BYTE. He manages a 70-node NetWare LAN and is the editor of the IBM Exchange and moderator of the lans conference on BIX, where you can reach him as "barryn."

HMA DOS 5.0 XMS BUFFERS UMB 386MAX 486SX DRIVERS 386SX NETWORKS TSRs BLUEMAX C&T 286





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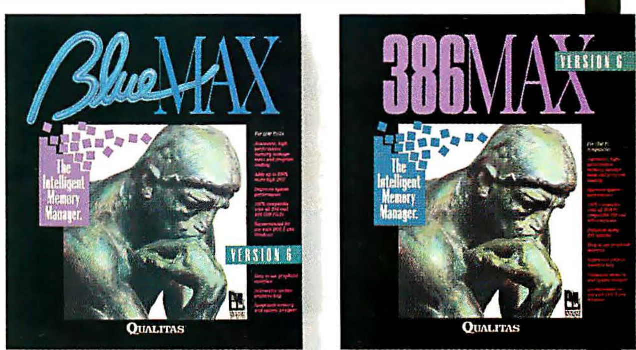
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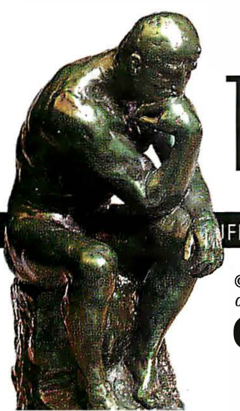
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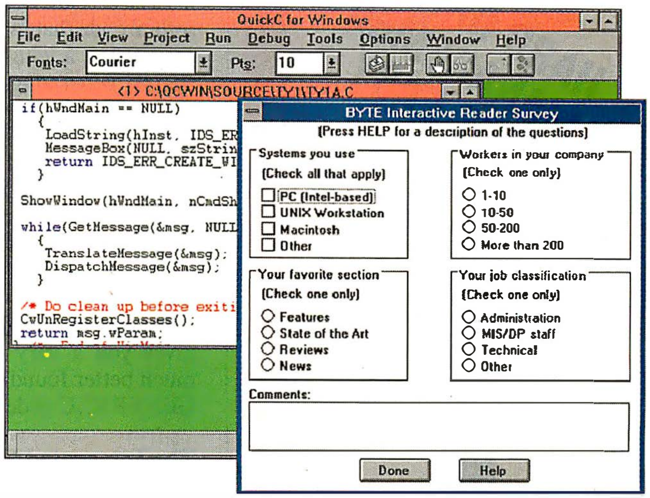
SOFTWARE

Swift Programming for Windows, in Windows

TOM YAGER

Windows programs may be easy to use, but as any experienced Windows programmer will tell you, they're a pain to write. That pain comes partly from the complexity of Windows itself. Even more bothersome, Windows C programming tools traditionally run under DOS, which requires cumbersome switches between environments to develop and debug your code.

Microsoft's QuickC for Windows changes all that, at least for those C developers who work on simple Windows applications, or would like to. The *Quick* in QuickC for Windows has a broad meaning: Microsoft bills the product as the fastest way to develop C programs for Windows. After working with it for a while, I think the company's right.



The QuickC for Windows integrated environment places an editor, a compiler, a debugger, and other tools under the control of a central interface.

Setting Up

I installed QuickC for Windows on a Toshiba T2000SX laptop with 5 MB of memory and a 60-MB hard drive. I ran Stacker 2.0 on the hard drive to give QuickC a little more room to breathe. As with most Windows programs, QuickC's installation is almost completely automatic. The standard installation takes up a bit over 6 MB, although you do have the option of selecting only those portions of the package you wish to install.

The product's hefty size results from its incredible completeness. QuickC for Windows includes everything necessary for developing Windows programs, so there's no need for the Windows Software Development Kit (SDK). There are also several sample applications and a set of help files that, by themselves, justify the cost of this package.

Help Is on the Way

If you're learning Windows, or learning C, or (heaven help you) tackling both at once, I can think of no better place to start than with QuickC for Windows. The help system is more complete, and more *helpful*, than any I've seen. Wading through Microsoft's examples, or anyone's C or Windows code, for that matter, becomes much easier: When you come across a confusing function call, C keyword, Windows structure definition, or other entity, just double-click on it and press F1. There are copious hypertext links to other help entries, and QuickC's help system adds embedded icons representing major subject groups. There are even source code samples in some of the help file entries.

With my 5 MB of system memory, I hopped in and out of the QuickC for Windows help system with relative ease. On systems with less memory, the Windows help system can be a drain on resources, and it becomes much less effective as an aid when you have to wait several seconds for it to pop up. The problems of the standard Windows help system are magnified by QuickC for Windows; it updates the help system executable file, WINHELP.EXE, with a larger, more capable one during installation.

Supporting Roles

While QuickC is (obviously) a compiler, that portion of it seems almost incidental compared with the rest of the package. QuickC for Windows includes a valuable set of tools: the Dialog Editor, for visual layout of dialog boxes; the Image Editor, for editing graphical objects (primarily icons and cursor shapes); QuickCase:W, a simple applications generator; and behind-the-scenes tools, which include the linker, resource compiler, and library manager. Of these, the most visible are the Dialog Editor and QuickCase:W.

The Dialog Editor should be familiar to experienced Windows programmers, but it will also give you déjà vu if you've used Visual Basic; the Dialog Editor's interface shares much with this other programming environment. In it, you create dialog boxes (windows that pop up to collect information from the user) by dragging buttons, text fields, labels, list boxes, and other interface objects into a prototyping window. The editor lets you assign unique names and ID numbers to your objects either as you create them or later as you select the objects one at a time and edit their name and ID fields.

The Dialog Editor isn't as capable as some I've worked with, but it gets the job done. When you're finished, the editor saves the dialog box, or boxes, that you created during your session to a set of files: a resource (.RES) file, an include (.H) file, and a .DLG file. The .DLG and .H files get `#included` into your application's resource script (.RC) file, while the .RES file is the Dialog Editor's reference copy of your interface. The .RES extension is also used by the resource compiler (a required step in the Windows development process), and that complicates things; Microsoft should have chosen a unique extension for the Dialog Editor's reference files.

QuickC for Windows includes a rudimentary code generator, QuickCase:W. This program, which is licensed from Caseworks, lets you build a Windows application by drawing a prototype of its interface; it's programming, WYSIWYG-style. The QuickCase:W main window is a slight superset of the prototype window, and you construct your interface through a combination of mouse and keyboard actions. I found this a little cumbersome; there are too many things you *must* do from the keyboard. Perhaps the best thing about QuickCase:W is how

easy it makes building menus. You can link menu items to certain actions, including the popping up of dialog boxes (created with the Dialog Editor).

When you've finished building your interface, QuickCase:W churns out the source code that makes it work. This process takes a *long* time, so I'd advise against generating your code before you are completely finished. What you get, however, is worth the wait: a full set of files, ready to load into QuickC for Windows and compile directly. Your application won't do much until you add your own code, but the QuickCase:W code generator places comments (how heavily it comments is up to you) in areas where you need to add functional code. This gives you a very workable skeleton—a much better foundation than Microsoft's GENERIC.C code example.

The Integrated Environment

You can't buy a compiler these days without some kind of integrated environment coming along for the ride. QuickC for Windows' integrated environment, unlike some others, actually enhances your productivity by bringing together all the essentials in one customizable interface (see the screen).

The editor and debugger work through child windows of the main QuickC window; you can have as many of them open as you like. To avoid having to open them all again when you rejoin a project later, QuickC for Windows lets you save several named window configurations.

I expected QuickC for Windows to cut some corners compared to Microsoft's so-called Professional Development System, and the primary loss of functionality is in the debugger. The debugger that's part of the integrated environment doesn't match CodeView (QuickC for Windows can generate CodeView-compatible debugging data), but it will help you zero in on the problems you're likely to encounter in small applications. Single-stepping, breakpoints, and watch expressions are part of the debugger's repertoire, and that's a good start. What you won't get is support for expression evaluation, the ability to watch Windows messages fly around, and some of the other "advanced" debugging features.

Know Thy Limitations

QuickC for Windows is not the only set of Windows development tools that any programmer could ever need. You may get involved in a project that's simply too big or too complicated for QuickC for Windows to handle. But QuickC for Windows is enough to get new programmers started, cheaply and easily, and it's also just right for the kind of small, relatively simple applications that dominate most programmers' to-do lists.

Obviating the need to switch between DOS and Windows also makes QuickC for Windows a more comfortable place to work than the typical Microsoft C/Windows SDK environment (if you can call it that). So QuickC for Windows can also serve as a nice launching pad for larger projects. In general, if you write Windows C programs, or would like to start, grab a copy of QuickC for Windows. ■

BYTE ACTION SUMMARY

■ **WHAT MICROSOFT QUICKC FOR WINDOWS IS**
A Windows-hosted C development system for the creation of Windows and DOS programs.

■ **LIKES**
Everything needed for Windows development is in one package. The program also includes a bundled applications generator and remarkably comprehensive on-line documentation.

■ **DISLIKES**
Lack of dual media types, a sluggish applications generator, and a limited debugger.

■ **RECOMMENDATIONS**
QuickC for Windows is a great starting system for budding Windows developers, and it's a well-designed integrated environment for experienced programmers.

■ **PRICE**
$199

■ **FOR MORE INFORMATION**
Microsoft Corp.
1 Microsoft Way
Redmond, WA 98052
(800) 426-9400
(206) 882-8080
fax: (206) 936-7329

Circle 1226 on Inquiry Card.

Tom Yager is a BYTE technical editor and author of the book UNIX Program Design and Development for IBM PCs *(Addison-Wesley, 1991). He can be reached on BIX as "tyager."*

SYSTEM

Apple Reinvents the Notebook

TOM THOMPSON

For two years, Apple's Macintosh Portable was the butt of jokes. After all, its suitcase-size, 18-pound bulk didn't measure up to notebook-size DOS computers that weighed 5 to 7 pounds. But at last fall's Comdex, Apple reentered the notebook market with a vengeance when it introduced three PowerBooks—notebook-size Macs that weigh from 5 to 7 pounds (see "A Peck of New Apple Macintoshes," November 1991 BYTE). These new Macs, with their ability to read DOS floppy disks, transparently connect to an office's AppleTalk network, and print to fax, make on-the-go computing easier and more productive than ever.

Meet the PowerBooks

All three PowerBooks (see photo 1) have 640- by 400-pixel screens and two expansion slots. One slot is for added memory; the other is for a fax/modem board. The $2299, 5.1-pound PowerBook 100 is based on a 16-MHz 68000. It has a 9-inch supertwist LCD, 2 MB of RAM, and a 20-MB hard drive (see photo 2). It's basically the Mac Portable's hardware and ROMs in a much smaller package, one that will easily fit inside a briefcase. The most noticeable difference between the two computers is that the PowerBook 100 does not have a built-in floppy drive, although Apple offers an external SuperDrive as an option. The external floppy drive runs off the PowerBook 100's battery, and it has a cover to prevent debris from getting into the drive.

The PowerBook 140 and 170 are slightly larger and heavier (6.8 pounds), have an integral SuperDrive, and use the more powerful 68030 processor. They also have an Enhanced Apple Digital Sound Chip (EADSC) for high-quality sound output, plus sound recording circuitry and a microphone. The $2899 PowerBook 140 uses a 16-MHz 68030 and includes 2 MB of RAM, a 20-MB hard drive, and a 10-inch supertwist LCD. The $4599 PowerBook 170 has a 25-MHz 68030, a 68882 FPU, 4 MB of RAM, a 40-MB hard drive, a fax/modem board, and a 10-inch, high-contrast, active-matrix LCD screen (see photo 3).

continued

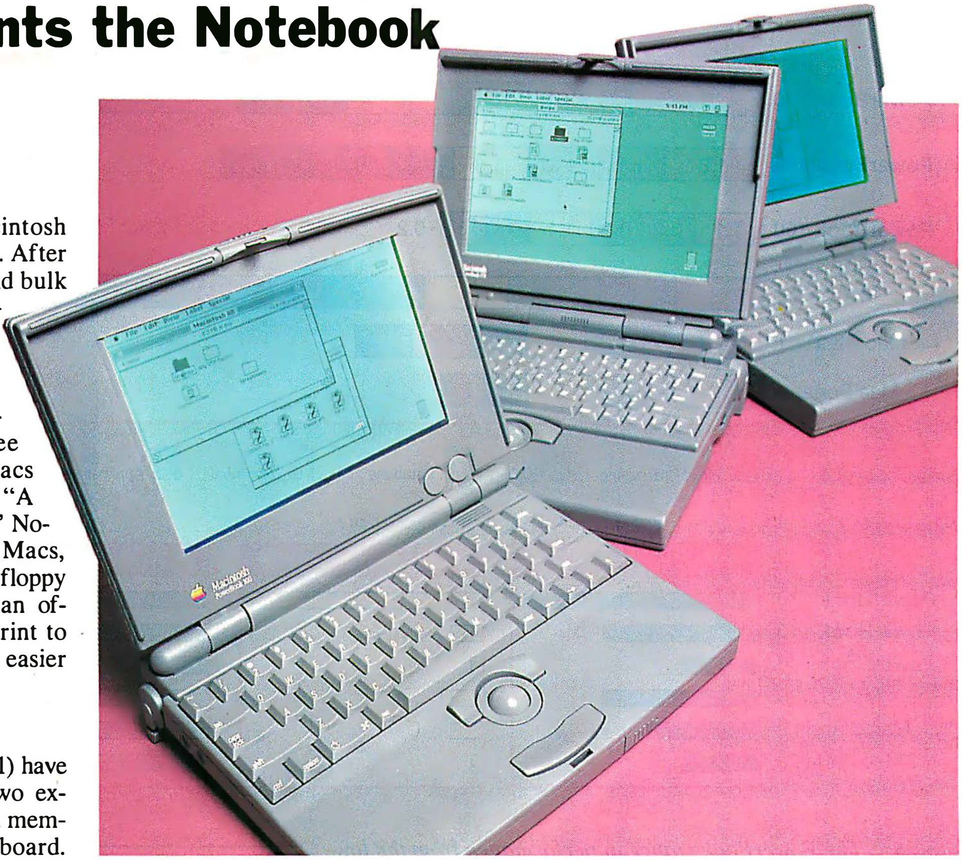


Photo 1: *Apple's PowerBook 170, 140, and 100 set the standards for portability and ease of use.*

BYTE ACTION SUMMARY

- **WHAT THE POWERBOOKS ARE**
  Notebook-size Macintoshes.
- **LIKES**
  Sturdy, ergonomic design, excellent weight, and a centrally located trackball make carrying and using a PowerBook a snap. Fax capabilities are closely integrated with applications software and easy to use. Remote networking software has superb security features.
- **DISLIKES**
  Battery life is shorter than that of the Mac Portable, and remote networking software's 2400-bps transfer rate limits the size of print jobs or file copies.
- **RECOMMENDATIONS**
  For cost-conscious users doing light-duty tasks, the PowerBook 100 with external floppy drive is a good buy. For those who demand more power, the PowerBook 170's 25-MHz parts deliver top Mac performance in a notebook.
- **PRICE**
  PowerBook 100, $2299
  PowerBook 140, $2899
  PowerBook 170, $4599
- **FOR MORE INFORMATION**
  Apple Computer, Inc.
  20525 Mariani Ave.
  Cupertino, CA 95014
  (408) 996-1010

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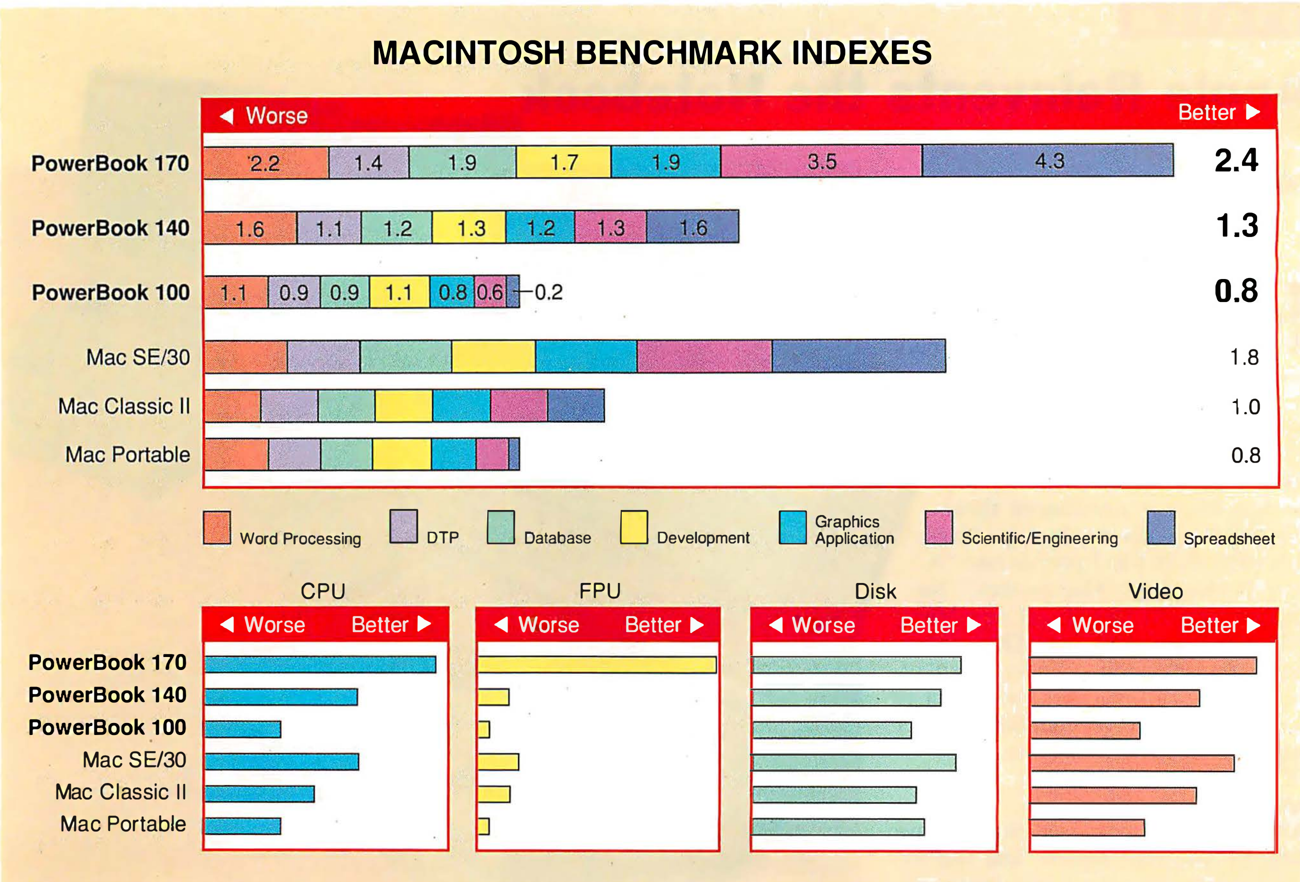


Figure 1: *The PowerBooks range in performance from the low-end PowerBook 100 to the high-end PowerBook 170. Each approximates the performance of an older Mac model, from the Mac Portable–like PowerBook 100 to the Mac IIci level of the PowerBook 170.*

All machines were tested running System 7.0.1. Except for the Dhrystone test, all results are indexed. For each test, a Mac Classic II = 1, and higher numbers indicate faster performance. The floating-point benchmarks use the SANE library. Comprehensive test results and detailed configurations are available for all machines on request.

	Dhrystones
PowerBook 170	4166
PowerBook 140	2941
PowerBook 100	1923
Mac SE/30	3125
Mac Classic II	2000
Mac Portable	2000

Test and Measurement

I tested each of the three models for performance and battery life. Apple shipped the PowerBook 100 and PowerBook 140 to BYTE with 4 MB of RAM and an optional fax/modem board. All three systems got along well with my collection of applications, INITs, and the benchmark testing software. I had only one problem—a crash with Suitcase II 1.2.11.

Figure 1 shows the results of BYTE's performance tests. The PowerBook 100, with the heart of a Mac Portable, turned in Mac Portable performance, as expected. Interestingly, the humble Classic II musters slightly more power than a PowerBook 100, but then it does pack a 68030 CPU. The PowerBook 140 puts up more or less the same performance as an SE/30 or IIcx, although its lack of an FPU makes it slower at pure number crunching. The PowerBook 170 is basically a notebook Mac IIci, except for the slightly slower LCD screen. Both the 140 and 170 models are candidates for portable desktop computers.

Sound reproduction on the higher-end systems with the EADSC doesn't quite match that of the Quadras, but it does offer better quality than current Mac II systems. You'll notice an occasional pop or crackle when power-conservation software switches the sound circuitry off several seconds after the PowerBook plays a sound.

I measured battery life both qualitatively and with BYTE's new notebook battery tests. These are the same scripted tests we use to test DOS notebooks; they use the same testing rig and the same script (see "Measuring Speed and Endurance," page 218). I've ported the support software of these tests to the Mac to get battery-life estimates.

Figure 2 shows the results. None of these systems lasts as long as the Mac Portable: It outlasted them by several hours. The times obtained are nearly double those of Apple's, but that's because our tests are based on a 55 percent duty cycle (display backlight set to half its maximum intensity, with the notebook active about half the time and idle the rest), while Apple's estimates are based on continuous, heavy-duty activity with the backlight intensity set to maximum. My experience indicates that battery life can range from about 45 minutes (performing a download with display intensity at maximum and continuous disk I/O) to a little over 2 hours if you can run the application in memory alone.

Based on these seat-of-the-pants observations and our battery tests, Apple's estimates seem reasonable. Remember that the amount of charge and abuse the battery has taken can affect running time as well. This explains the shorter intervals I got with the Powerbooks, because I

New QEMM-386 v6.

There's no better way to manage your memory.

"It's nothing less than a dream come true"
—*Steve Gibson InfoWorld 8/26/91*

Suddenly PC users have a lot of memory managers to choose from. Seems that everyone has figured out what users have been telling us for years: they need every last 'K' of available memory between 640K and 1 megabyte—especially if they're running on a network. Or using TSRs.

Our new QEMM-386 version 6 is the best way to get the most out of memory. It 'pools' all your memory so that it's available in whatever form your programs need—expanded or extended. You don't even need to know the difference. QEMM does it all for you. Instantly. Whereas DOS 5, for example, requires you to figure out what you need, then manually allocate memory and re-boot every time you need to change.

PC WEEK ANALYST'S CHOICE

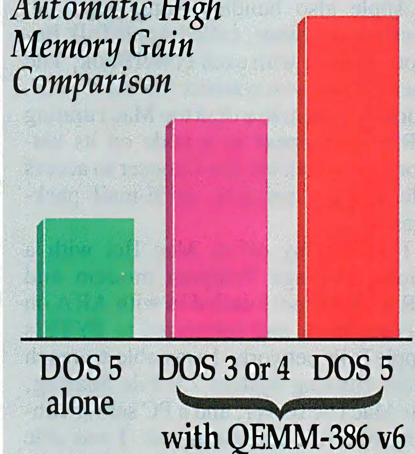
As for the all-important 'conventional' memory area, our new version 6 increases the amount of memory freed-up. Our exclusive 'optimize' feature automatically seeks out TSRs and device drivers and moves them into high memory—the area between 640K and 1 megabyte. All you have to do is type 'optimize'.

QEMM-386 v6 finds more high memory than any other memory manager. *Byte Magazine's* tests showed it produced net memory gains of 21K to 132K over DOS 5.0 alone, for instance.

#1

QEMM is the number one selling PC utility.

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Our breakthrough 'Stealth' technology makes available areas normally taken up by ROM. Areas that QEMM-386 can use to load memory-hogging drivers and TSRs. Big programs can get the memory they need to run fast and efficiently. And you get to have your TSRs.

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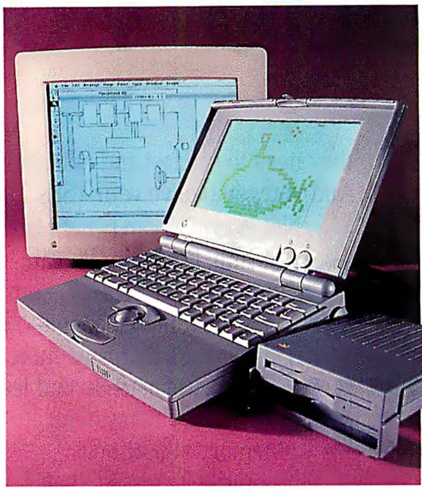


Photo 2: *The PowerBook 100, with an Envisio memory/video expansion board. Envisio's Notebook Display Adapter is driving a second screen on the AppleColor 13-inch monitor in the background while providing an extra 2 MB of RAM.*

used them constantly, never allowing the batteries to get a full charge. Also, the PowerBook 100 arrived with its battery completely discharged, which can damage the battery. This is why, despite its low-power components, the PowerBook 100 conked out sooner than the 68030-based versions.

Keep in Touch

The PowerBook 170's communications device is a 9600-bps send-only fax/2400-bps data modem. A PowerBook with this option becomes a powerful tool for keeping in touch with the office and clients while on the road. You can send E-mail to those offices that use on-line services.

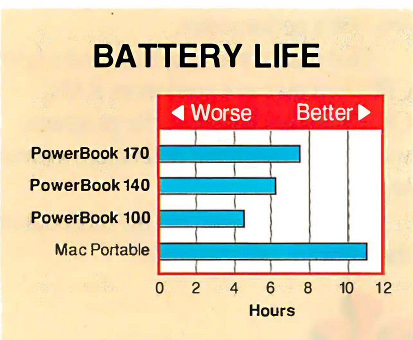


Figure 2: *Battery test results show that the new PowerBooks aren't as long-lived as the old Mac Portable. However, the greatly reduced weight and better screen compensate for the shorter battery life.*

For those that don't, you can fax documents to their fax machine.

The Fax Sender software bundled with the Apple fax modem allows you to print a document loaded with tables, charts, artwork, and scanned images to a fax machine. It has two components: a background imaging and transmittal application, and a Chooser-selectable driver. The application is analogous to the Print Monitor, the Mac's background printing software.

To send a fax, you launch the application that created the document, pick Fax Sender in the Chooser, and issue the Print command. Fax Sender is easy to use and works with documents that have a mix of different typefaces. With TrueType or ATM, fonts are imaged at high resolution, making for great output—certainly a good way to impress a customer. I sent PageMaker 4.0 documents to the office fax while traveling, and I even faxed PostScript drawings from Adobe Illustrator 3.0.1 without problems.

Apple also bundles AppleTalk connectivity software, called AppleTalk Remote Access, with each PowerBook. The package lets you connect via the PowerBook's modem to a desktop Mac running ARA and appear as a node on its network. You then use the Chooser to access file servers, printers, or E-mail packages.

I set up my office Mac IIci with a Global Village Teleport modem and ARA. At home, I called in with ARA on a PowerBook and connected to BYTE's AppleTalk network. I was able to reach Macs running System 7.0 File Sharing, our Mac file server, and a PC server running NetWare for Macintosh. I was able to copy small files and print short jobs with no trouble. But if you think LocalTalk's 230-Kbps rate is slow, a 2400-bps network connection will really try your patience.

A PowerBook in Your Future?

If you use a GUI to keep your computing tasks sorted out, the Mac does it best, especially for notebook computing. The PowerBook's centrally located, built-in trackball favors neither hand and avoids the bolt-on headaches that plague most PC pointing devices. The integration of applications with the communications software has no equal. I expect PC notebooks, which have already mimicked the Mac's GUI with Windows 3.0, to imitate many PowerBook features. I'd like battery life to be longer, but for now, I'll carry plenty of spare batteries.

With a fax/modem board installed, a

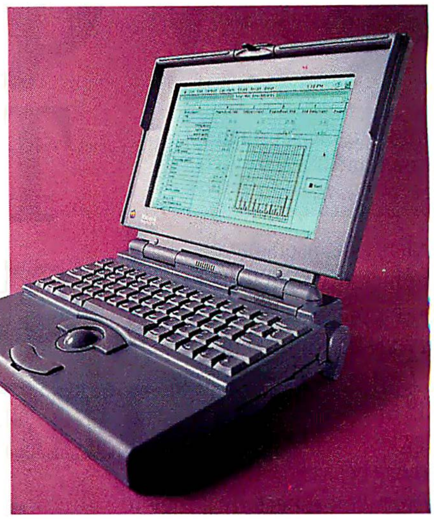


Photo 3: *The PowerBook 170 delivers Mac IIci performance. Both it and the PowerBook 140 have 32-Bit QuickDraw and support for virtual memory in their 1-MB ROMs.*

PowerBook provides several ways to keep in touch with the office or with customers. I've frequently plugged a PowerBook into a phone jack and made use of fax, terminal, and ARA in one sitting. All I had to do was point and click to use another service without rebooting. With software that supports sound, you can use the PowerBook 140 and 170's microphone to voice-annotate documents. With all the capabilities the PowerBook offers, the question becomes, Where can I get one?

Don't let the PowerBook 100's middling benchmark scores fool you into thinking this is a wimpy machine; it's not. I've used it (and a Mac Portable before that) to telecommute and even to develop software with Symantec's Think C compiler. The PowerBook 100 makes a cost-effective "data bucket" for those who want to write reports or use a terminal program.

If you need desktop power for complex reports, professional graphics, and big spreadsheets, consider the PowerBook 140 and 170. I recommend the PowerBook 170, since it comes with a crisp screen, larger hard drive, more RAM, an FPU, and the fax/modem board as standard equipment. And you'll enjoy its 25-MHz computing power on the road or at your desk. ■

Tom Thompson is a BYTE senior technical editor at large. He has a B.S.E.E. from Memphis State University. Contact him on BIX as "tom_thompson" or on AppleLink as "T.THOMPSON."

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APPLICATION

WordPerfect for Windows

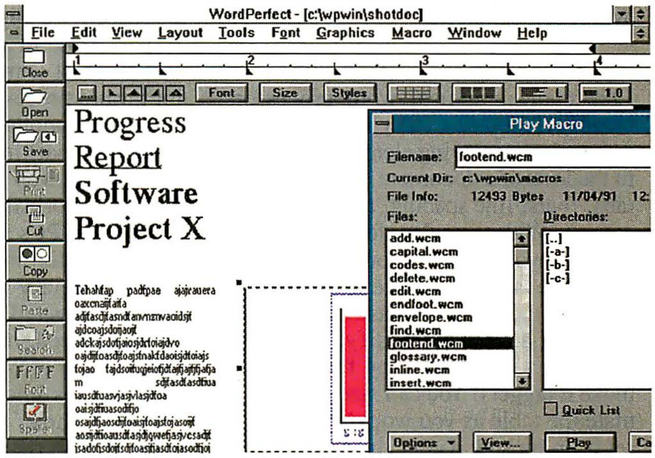
NICHOLAS BARAN

WordPerfect for Windows is a monster word processor. Like its chief rival, Microsoft Word for Windows, the program is packed with every conceivable feature short of higher-end desktop publishing tools. This program is a far cry from a text editor with a GUI slapped onto it. With its columnar text, formatting tools, and manipulation of graphics, WordPerfect for Windows can be used for many of the kinds of documents that are generally done with software like PageMaker or Ventura Publisher.

Although an in-depth comparison with Microsoft Word for Windows is beyond the scope of this review, I have used both Word and WordPerfect and was struck more by their similarities than by their differences. Both are much easier to learn than their DOS counterparts. In the never-ending features battle, these programs are approaching the saturation point, and it is difficult to differentiate them—it's much like comparing a Lincoln and a Cadillac.

With more than 200 menu options, WordPerfect for Windows incorporates all the functions that are found in today's WYSIWYG word processors, including basic column-layout capabilities, multiple fonts, macros, tables, indexing, and the ability to place and size graphics. The package also has an equations editor, a spelling checker, a thesaurus, and a file manager/viewer (called the File Navigator) that makes it easy to find documents (and also runs fast text searches). Being a good Windows program, the package takes advantage of the Clipboard and Dynamic Data Exchange, allowing you to establish "hot links" between other Windows documents (e.g., an Excel or Lotus 1-2-3 spreadsheet) and WordPerfect documents. Unlike the latest Word for Windows or Ami Pro 2.0, the program does not yet take advantage of Object Linking and Embedding. WordPerfect says those protocols will be implemented in "a subsequent release," probably within a few months.

This software demands high-performance hardware—nothing less than a 386 with 4 MB of RAM (which the company recommends) will do: While WordPerfect will run on a 286 PC with 2 MB of memory, the performance would be barely acceptable. Even on a 386, some operations—like scrolling down a half-page table—can seem sluggish. The full application occupies 9 MB of hard disk space, which, unfortunately, is becoming a common demand these days, but space-conscious users, like laptop owners, can choose to install a minimalist version (i.e., no macros, no file manager, no learning help, and no hyphenation) that takes up about 5 MB.



The Button Bar on the left side and the ruler at the top let you access frequently used commands and procedures easily. The window for playing macros is opened on the right.

CUA Menus or DOS Keys: Your Choice

With this new GUI version, the company has managed to maintain the look and feel of the traditional text-based WordPerfect while making it work like a Windows product. This challenge was complicated by the fact that the MS-DOS version of WordPerfect has traditionally relied on the IBM PC function keys, which have different functions running under Windows, as specified by the Common User Access (CUA) standard (developed by IBM and Microsoft as the standard keyboard and mouse interface for Windows and OS/2).

WordPerfect addressed this problem by providing two keyboard interfaces: the traditional DOS keyboard interface and the Windows CUA interface. You can choose the one you prefer. The program comes with a function-key template that has the CUA key codes on one side and the standard DOS codes on the other. I found the CUA interface easier and recommend using that even if you're a veteran DOS WordPerfect user. Since many keyboard operations are now easier to perform with the mouse, the transition to the CUA standard is not that difficult.

Overall, the program's developers have succeeded in striking a balance between WordPerfect and Windows. This program feels like a Windows product and behaves much like one, using the standard windowing system for cascading multiple windows, minimizing and maximizing windows, and so forth. You can shrink a window to get it out of the way and then maximize it when you need to work in it again.

On the other hand, the interface has changed considerably from the traditional DOS and Unix versions of WordPerfect. WordPerfect for Windows takes excellent advantage of the graphical environment and the mouse, with features such as an on-screen ruler, a Button Bar, and easy cut and paste. Veteran WordPerfect users will have to make some adjustments, but for the most part, these are positive changes. The main thing is that WordPerfect has maintained complete file compatibility with other versions of the product.

Incompatible Macros

Because of the CUA interface and the graphical environment, the company was forced to design a new macro language for its Windows version of WordPerfect. As with the keyboard interface, the DOS version of WordPerfect relies heavily on the function keys and Alt key for macro definition.

The program's new macro system includes a BASIC-like programming language that has loops and conditional

statements. Nevertheless, macros are easy to "record." There's a handy window for calling up a list of all macros and another window for viewing the contents of macros. WordPerfect provides facilities for at least partial conversion of DOS WordPerfect macros.

The Ruler and the Button Bar

Like many graphical word processors, WordPerfect puts a ruler at the top of the screen for specifying elements that relate to the look of a document (e.g., margins, tabs, fonts, line spacing, and text justification). With the ruler, formatting commands involve just a mouse-click on an icon. The table tool is one of the sharpest parts of the ruler. It basically lets you construct a table by modifying a simple grid (e.g., dragging it by the corner to make it bigger). You can size and manipulate the table as you would a graphic or set it up by specifying, in a little dialog box, the number of horizontal and vertical rows.

The company has also added a slick icon-based menu strip, called the Button Bar, where you can place commands, menu items, and macros that you use often and want to activate with a single click. This customizable feature is similar to the Smart Icons in Ami Pro. You can set up a different bar for different types of documents.

Portability a Big Plus

If you work in a mixed environment, WordPerfect is probably the best choice for a word processor. It now runs in one version or another on Windows, DOS, and OS/2 machines; Macintoshes; Next computers; Sun Sparcstations; Silicon Graphics workstations; IBM RISC System/6000s; PCs running SCO Unix 386 or SCO Xenix; machines running under AT&T System V and VAX VMS; and its original target, Data General minicomputers. Indeed, one of the most compelling features of WordPerfect is the portability of files among all these platforms.

For example, I tried opening a file using WordPerfect for Next: It opened up as if it were a native Next WordPerfect document. And WordPerfect for Windows on a 386-based PC opened a Next WordPerfect file without a hitch, including bit-mapped graphical images embedded in the document. While some of these platforms do not support the latest version of WordPerfect, at least the document structure is the same, providing a basic level of portability.

Weirdnesses and Weaknesses

I ran into a few minor problems with the product. In particular, the File Open function does not provide a simple method of listing available directories. You have to type in `C:\*.*` to see the root-level list of directories. Another annoyance is the disappearance of minimized windows (i.e., windows that you collapse to an icon). I could always find these minimized files, but on several occasions, it took more doing than should have been necessary. The problem is that the minimized icons don't always remain on the screen. Trying to launch a minimized file sometimes resulted in an unexplained "application error." Other users have reported the usual mysterious Windows crashes but said these incidents inexplicably dwindled the longer they used the program.

Some users have found inconsistency with "WYSIWYG" between the screen and the printer. Although inconsistency was sometimes the case when in regular mode—for example, the space between type and graphics could be misleading—the print-preview mode appeared accurate. I printed to a PostScript file in my tests and found no problems with output. The product includes some 900 printer drivers and can also use the Windows printer drivers, which should be plenty for most people.

There are some bugs that creep in when you're working with a page that has an image on it. For example, the program sometimes redraws the graphic incorrectly; after you save the file, however, it looks OK.

But these are fairly minor complaints; WordPerfect says it will fix them in a maintenance release. Despite the bugs, WordPerfect for Windows is a solid product. It improves on the DOS version in so many ways that users of that edition will be tempted to move to Windows just to run the new WordPerfect. And it's so much easier to use; the Windows version won't suffer from the rap that WordPerfect is too hard to learn. It's been a long time coming, but WordPerfect for Windows was worth the wait. ■

Nicholas Baran, a longtime WordPerfect user, is a consulting editor for BYTE and co-editor of Pen-Based Computing, *an industry newsletter based in Sandpoint, Idaho. You can reach him on BIX as "nickbaran."*

BYTE ACTION SUMMARY

■ WHAT WORDPERFECT FOR WINDOWS IS
WordPerfect for Windows is WordPerfect 5.1 adapted to the Microsoft Windows 3.0 environment. It's a graphical word processor with desktop publishing capabilities such as fonts and graphics, columns, and tables; a macro language; and a Button Bar.

■ LIKES
This is a good implementation of the Windows environment, yet it preserves file compatibility with other versions of WordPerfect. It provides virtually every feature you would want short of full-scale desktop publishing. Setting up document formats and tabular material is particularly easy. This package will nix the rap that WordPerfect is difficult to learn and use.

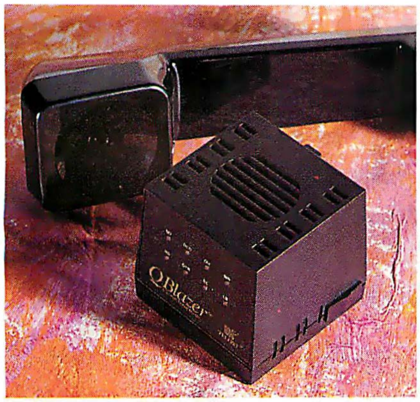
■ DISLIKES
Minor annoyances such as the File Open function and minimized window function need improvement. Bugs when working with graphics are troublesome. The sheer size and number of features can be overwhelming. Performance is less than zippy on anything less than a 386.

■ RECOMMENDATIONS
WordPerfect is a solid product backed by a solid company; it's particularly attractive if you use other computer systems running WordPerfect. Highly recommended.

■ PRICE
$495; upgrade, $99; additional site licenses, $349 with documentation, $295 without

■ FOR MORE INFORMATION
WordPerfect Corp.
1555 North Technology Way
Orem, UT 84057
(800) 451-5151
(801) 225-5000

Circle 1105 on Inquiry Card.



Telebit Modem QBlazes Through On-Line Space

The Telebit QBlazer modem is small (less than 2½ inches on a side), but it holds big capabilities: portable connectivity of up to 38,400 bps. The QBlazer, which will run off a 9-volt battery for about 2 hours, is designed primarily for on-line communications between high-capacity systems and portable personal computers. The high performance for asynchronous stream communications makes it ideal for serial line Internet Protocol network connections.

You won't find the built-in file transfer protocols of the Telebit TrailBlazer Series—PEP (Packetized Ensemble Protocol), XMODEM and YMODEM, Kermit, and UUCP—but you will find V.32 and MNP levels 1, 2, 3, and 4 for error-corrected data connections. Plus, you get both MNP level 5 and V.42bis data compression for effective data transfer of up to 38,400 bps.

The QBlazer can store two entire configurations of the nearly 50 registers as well as two phone numbers in nonvolatile memory. The modem supports all standard specifications from 300 bps (Bell 103J) through 9600 bps (CCITT V.32). The modem command language is a superset of the standard "AT" commands, so you can easily use it with all the common personal computer communications programs.

For $745, you get the modem, cables, manuals, external power supply, a travel pouch, and the communications and file transfer program MTEZ (from MagicSoft). Small, maybe even cute, the Telebit QBlazer opens up a huge world of interactive computing to users of portable computers.

Stacker 2.0 Squeezes Out More Space

When a BYTE Lab editor needed to free up some space on his Toshiba T2000SX's hard disk, we decided to give a couple of on-the-fly compression programs a shot. We learned that not all compression programs are created equal. But we did get the results we wanted when we tried Stac Electronics' Stacker 2.0.

The 30-KB program installed gracefully and automatically, and a few minutes later, we turned the T2000SX's 20-MB hard drive into a defragmented virtual 40-MB drive that not only survived 386 enhanced-mode Windows but every nasty application we could throw at it. We installed Stacker again after upgrading the T2000SX to a 60-MB drive, with similar results. It has been stable now for a lengthy period of constant use. Stacker 2.0 is marvelous: *very* fast, easy to use, and completely transparent. We recommend it.

SoftNode: A Different Kind of NetWare for Macintosh

With Insignia Solutions' PC emulators—SoftPC and SoftAT—Macintoshes can run DOS programs. Insignia's new SoftNode makes the emulated PC or AT a genuine NetWare client. Macs can then access a NetWare file system shared with DOS PCs.

Of course, you already have that capability if your environment includes PCs, Macs, and Novell's NetWare for Macintosh. But SoftNode gives Macs extra capability: They can run networked DOS applications and communicate directly with NetWare servers and clients over Novell's IPX transport. The product includes Open Data Link Interface (ODI) drivers for EtherTalk and AppleTalk, an IPX gateway/router, and a DOS 3.3 NetWare shell.

We tested SoftNode on a Mac Quadra 900 and a Mac IIci, both connected directly to an Ethernet-based NetWare LAN. Since we had a direct Ethernet connection, we needed only to drag a few files into the Insignia folder on the Mac, launch SoftAT, and run a DOS batch file that loads NetWare.

If you already have an Ethernet/LocalTalk router (at BYTE we're running Cayman Systems' GatorBox), the SoftNode router only needs to exchange packets at the AppleTalk/IPX level. Or SoftNode can manage both Ethernet/LocalTalk and IPX/AppleTalk routing. Either way, you'll need a gateway Mac that connects to the Ethernet and LocalTalk networks concurrently.

Insignia's NetWare implementation does everything by the book. The ODI-based IPX transport layer has performed flawlessly, so DOS programs that talk directly to IPX, such as Eicon Technology's Access/X.25, have run without a hitch. We ran the DOS version of a networked FoxPro 2.0 application, but the speedy Quadra became a slow AT in the process.

Clearly, the SoftAT/SoftNode combination isn't well suited to compute-intensive tasks. But if you've got a client/server application that's glued to DOS and IPX, and you need to have it materialize on a Mac, SoftNode looks like the right magic bullet.

—The BYTE Lab

Reviewer's Notebook provides new information—including version updates, new test data, long-term usage reports, and reader feedback—on products and product categories.

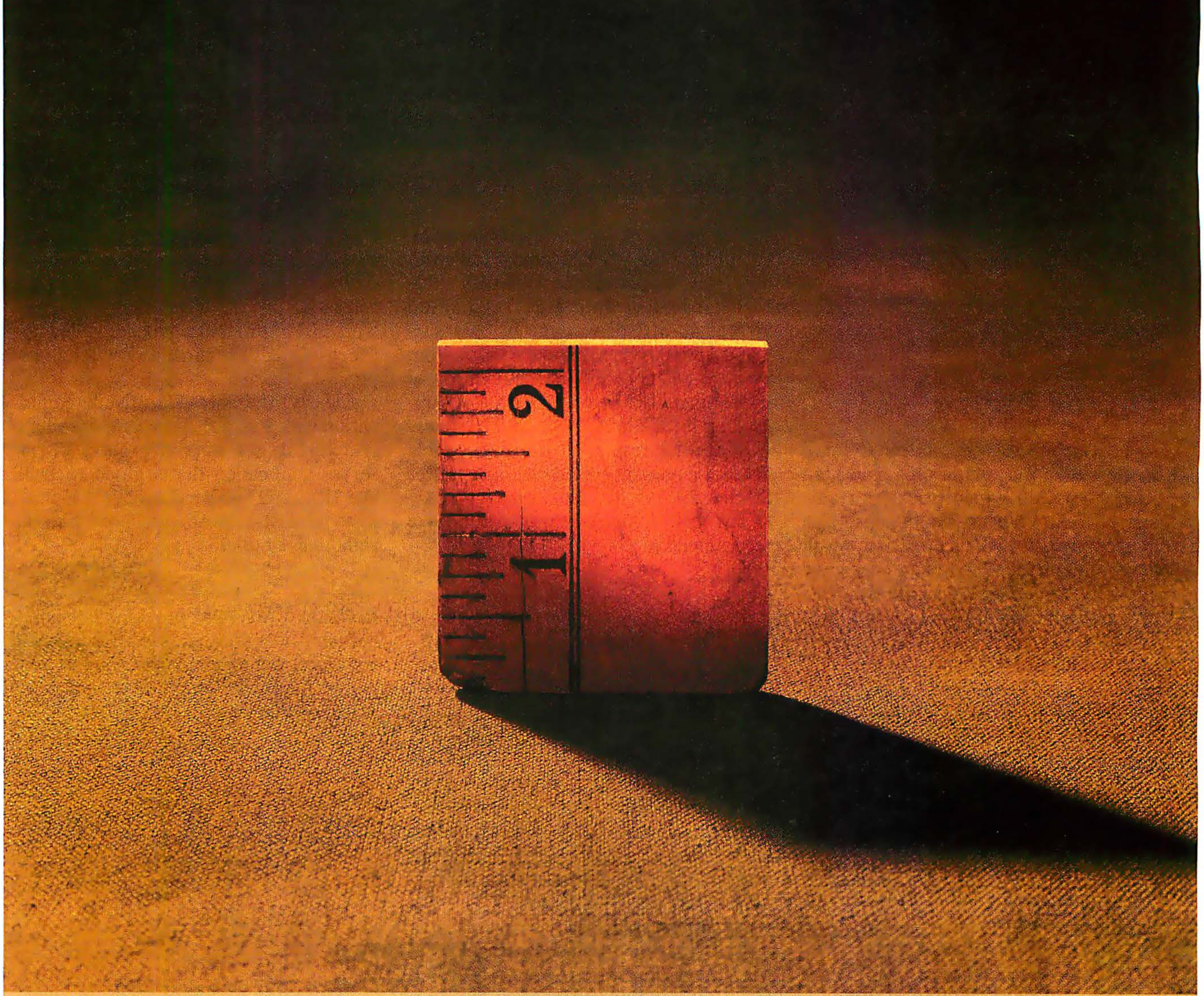
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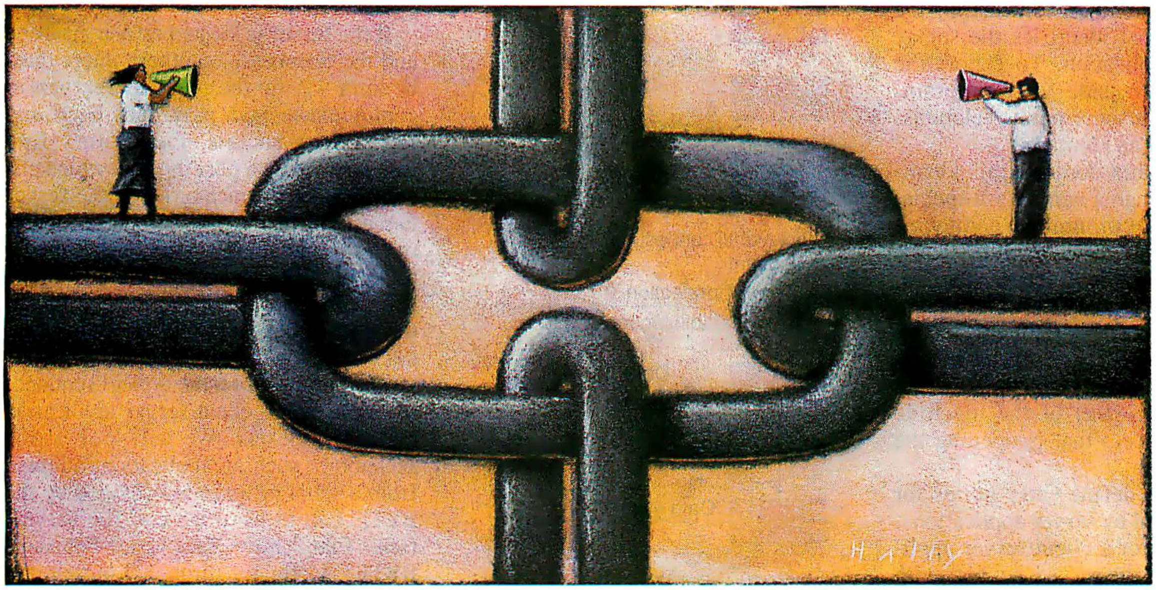
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TAPPING INTO SOCKETS



Here's how to build a portable client/server application for TCP/IP networks

The Berkeley Standard Distribution Unix model for interprocess communications is known as "sockets." A socket is a general-purpose IPC mechanism useful for both stand-alone and networked applications. In BSD Unix, sockets are part of the kernel and are accessible by way of system calls. Non-BSD Unix systems provide sockets in the form of libraries—as do other operating systems, including MS-DOS, Mac OS, and OS/2. You can use sockets to distribute a single source code client/server application throughout a population of machines running any of these operating systems, so long as each runs the requisite IP substrate.

If you can carve up an application into processes that run on separate computers, you get the most mileage out of the special capabilities of each computer. One computer, a file server, might control an array of high-capacity drives, applying most of its computing power to the efficient management of all this storage. Another machine, the compute server, may hit its stride when performing complex calculations. Still others—workstations and personal computers—may serve best as user-interface engines running Microsoft Windows, MultiFinder, or the X Window System.

Harnessed to a network, this collection of computers works most efficiently when you can assign the right kind of work to each kind of machine: disk I/O to the file server, number crunching to the compute server, and user interfaces to the display servers. To achieve that distribution of labor, the processes on each of these machines must be able to communicate with the appropriate processes on the other machines. That's where sockets come in.

Anatomy of a Socket

The sockets model generalizes the standard I/O functions that you find in common C language libraries: `open()`, `read()`, `write()`, and `close()`. It augments these functions with data structures and methods that enable these I/O functions to pass data through network connections. The characteristics of a socket are determined by the following:

- the domain in which the socket operates,
- the name structure to which the socket is (optionally) bound,
- the socket type, and
- the socket protocol.

On BSD Unix systems, the most common domain is called simply "Unix" and typically governs the IPCs conducted among processes running on a single system. In that domain, sockets are used for, among other things, the pipes that connect the flow of data from the standard output of one process to the standard input of

ILLUSTRATION: GREG HALLY © 1992

another. In this installment of Some Assembly Required, we focus instead on the Internet domain that governs IPCs that travel through networks.

What about that "optional name structure" mentioned above? When you program with ordinary files, the `open()` call requires as an argument the name of a file. But when you create a socket using the `socket()` call, you specify the socket domain, the socket type, and the protocol; there is no filename or path. There is only a socket number (returned by the function call) that identifies the socket within your application. To export the socket for use outside your program, you've got to do some public relations; the socket needs an identity.

In the BSD Unix domain, this identity—little more than a name for a special file—enables your program to communicate with other processes running on the same system. In the Internet domain, however, the socket needs a more complex identity. The structure of this identity is defined in `<netinet/in.h>` and includes a port number and the Internet address (*netid/hostid*) of the machine running the process that is opening the socket.

Port numbers define entry points for services provided by server applications. The server part of a client/server application associates the service it offers with what is called a "well-known" port number. On Unix systems, port numbers of commonly used well-known services are listed in `/etc/services`. Avoid these numbers unless you want to either use or provide one of the services.

The Internet address is a 4-byte (32-bit) number. This number is usually written as four separate decimal numbers delimited by dots; for example, 192.1.1.5. The Internet address is often associated with a host ID name; the file `/etc/hosts` contains the address-to-name mapping. You can call `gethostbyname()` to inquire about a system by name, or `inet_addr()` to ask about it by address.

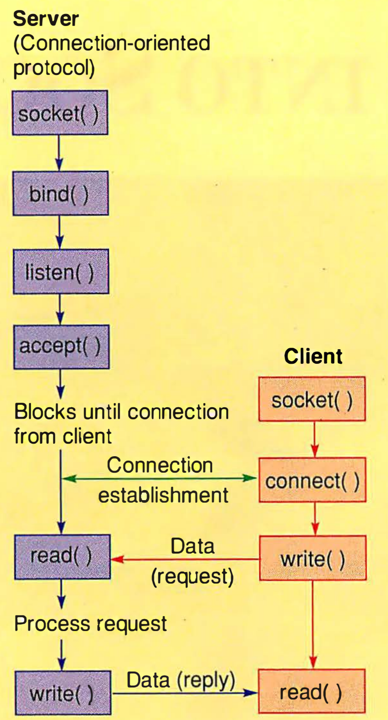
Types and Protocols

In IP terminology, the basic unit of data transfer is a *datagram*—which is basically a header followed by some data. Datagrams are an "unreliable and connectionless" delivery system. But this doesn't mean that they are a useless delivery system; it simply means that it is not the responsibility of the Internet to confirm that datagrams are delivered. Programs that use IP must do this for themselves, or at least there must be a higher-level protocol (e.g., TCP) that provides the service of reliability.

A socket that works only at the datagram level is called a *datagram socket*. A *stream socket*, on the other hand, requires a reliable connection. Once a connection has been established with a stream socket, the data appears to flow as a constant stream from one point to another. This is called a *connection-oriented* protocol. The examples we'll present in this article use stream sockets.

Another type of socket is the *sequenced packet socket*, which belongs to the XNS (Xerox Network Services) domain. Still another type, which has the most attractive name of all, is the Reliably Delivered Message socket. A fifth type is the *raw socket*, used by special, privileged programs to access very low-level protocols. For our purposes here, though, we'll focus just on the stream socket and its application in the development of client/server applications. Master this, and the rest will be easy.

ANATOMY OF A SOCKET-ORIENTED TRANSFER



The typical flow of events for a connection-oriented transfer using sockets. (Figure courtesy of Unix Network Programming *by W. Richard Stevens, Prentice-Hall, 1990.)*

The Client/Server Connection

TCP/IP stream sockets enable a client program (or *process*, if you prefer) to communicate with a server program. In the client/server model, the server offers some "service" that clients can use. A database server, for example, handles requests from database clients. With such an architecture, several users running the client application can simultaneously add, modify, and retrieve records, while a single process can reliably control access and locking.

If the server is located on one machine and the clients are on others, there must be some way for the clients and servers to communicate and pass data back and forth. With sockets, the server's first task is to set up a port through which clients can communicate. Once the server has established a port (or ports) and is open for business, it waits for customers to serve. When a client comes to a port (i.e., connects a socket to the port), then the actual client/server business gets under way.

The figure shows the typical sequence of events for a client/server application that uses sockets. We will look at the skeleton of such an application, adapted from a set of programs developed by the BYTE Lab to test high-end file servers (see "File Servers Face Off," February BYTE). Listings 1 through 5 present the essence of these programs, the socket foundation for any client/server application.

Naturally, we need a server program with which to communicate. Following an example in the book *UNIX Program Design and Development for IBM PCs* by Tom Yager (Addison-Wesley, 1991), we collected all the socket initialization functions in a utility function, `createService()` (see listing 1). This function takes the port number we wish to use (13760 in our case) and returns a socket number (or a negative number if it fails).

Note that all the initialization steps take place in this function, including `socket()`, which creates the socket; `bind()`, which binds the new socket to the name/address structure; and `listen()`, which specifies that the socket will be used as a server. If successful, the server program now "owns" this port, and no other programs can connect to it for the purpose of creating a server. But the port is not actually open for business until the server program calls `accept()`.

Once the socket has been initialized, the server program can then handle a client connection (see listing 2). The `accept()` function does not return until

Listing 1: *A simple version of* `createService`. *First we created the address structure. Then we called the* `socket()` *function to create a TCP socket resource. The* `bind()` *function associates the socket resource with the port number and the host Internet address in the address structure. Once this is complete, the server then states its intention to* `listen()` *on that particular socket for communication from clients.*

```
int createService( ushort port )
{
   struct sockaddr_in serverSockAddr;
   int serverSocket;

   /* clear and set name/address structure */
   bzero( &serverSockAddr, sizeof( serverSockAddr ));
   /* Convert port number to network byte order. */
   serverSockAddr.sin_port = htons( port );
   serverSockAddr.sin_family = AF_INET;
   /* Allow connections from all clients. */
   serverSockAddr.sin_addr.s_addr = htonl( INADDR_ANY );

   /* Create TCP socket. */
   serverSocket = socket( AF_INET, SOCK_STREAM, 0 );

   /* Bind socket to port and client-address range. */
   bind( serverSocket, &serverSockAddr,
    sizeof( serverSockAddr ));

   /* Set up a queue for up to five connection requests. */
   listen( serverSocket, 5 );

   return serverSocket;
} /* createService */
```

Listing 2: *The server (parent) process.*

```
/* Define a port on which to listen. */
#define Port (ushort)13760

main( void )
{
   struct sockaddr_in clientSockAddr;

   int serverSocket;
   int clientSocket;
   int addrLen;
   int pid;

   short result = 0; /* assume success */
   Boolean done;

   /* Create a new socket and init TCP service on selected
    port. */
   serverSocket = createService( Port );

   addrLen = sizeof( clientSockAddr );

   /* Loop while looking for client connection requests. */
   while( 1 )
   {
   /* The following call blocks until a client wants to
    connect. */
   clientSocket = accept( serverSocket, &clientSockAddr,
    &addrLen );

   pid = fork( );

   if( 0 == pid )
   {
   /* the code for the child server goes here. */
   .
   .
   .
   }

   close( clientSocket );
   } /* while */

   return result;

} /* main */
```

a client communicates with the server. This function then returns with a new socket value, which is used for all further communications with the newly connected client task. The well-known socket only serves to establish the initial hookup between the two processes. A socket arbitrator then moves the conversation to another socket number—one that it picks.

Parent and Child

There are now two sockets. One is bound to the well-known port and was used to establish the initial connection. It is now free to listen for further clients wanting to communicate. The second socket is connected to the client that has just begun communicating.

We don't want to have an `accept()` block the business that is going on with the established socket connection, so we should take advantage of the fact that we are running in a multitasking operating system and split the server into two separate processes. The original process will continue looking for new clients, and the spawned process will handle requests pertaining to the recently established client/server connection.

We achieve this by executing a `fork()` function, which starts a second copy of the program. At this point, there are two programs executing the same code, but we want them to exhibit different behavior. Both programs are at the same point in execution; they've just returned from a `fork()`.

Stream sockets are not the only kind of sockets that you might want to use across a network.

A process can determine whether it is a parent or a child by examining the process identifier (called the *pid*) returned by the `fork()` function. If the pid is 0, then the process is the child and can go ahead with its business. First, though, it should do some cleanup by closing the original socket, which it no longer needs (see listing 3).

However, the original server process (i.e., the parent) needs to continue listening on the well-known socket for other clients that wish to communicate, and therefore it should loop back to `accept()`. This is the purpose of the `while(1)` loop in listing 2.

When the server receives a command to terminate, it should call `shutdown()` and then `close()` (see listing 3). The `shutdown()` function takes as parameters the socket to be shut down and a second, numeric, value. This value may be 0, 1, or 2 and determines how much of

Listing 3: *The child-server code, ready to provide services.*

```
if( 0 == pid )
{
close( serverSocket ); /* child doesn't need original
 socket */
done = FALSE;

while( !done )
{
#define MaxBufLen 256
ushort bufLen = MaxBufLen;
ushort opcode;
char buffer[MaxBufLen];

readShort( clientSocket, &opcode );
switch( opcode )
{
/* some case statements for services */
.
.
.

}
}

shutdown( clientSocket, 2 );
close( clientSocket );
}
```

Listing 4: *A simple version of* connectToServer, *used by the client to open a connection with a server.*

```
int connectToServer( char *serverName, ushort port )
{
   struct sockaddr_in serverSockAddr;
   struct hostent *serverHostEnt;
   int toServerSocket;
   ulong hostAddr;
   short result = (-1); /* assume failure */



   /* Clear and set server address structure. */
   bzero( &serverSockAddr, sizeof( serverSockAddr ));
   hostAddr = inet_addr( serverName );
   if( (long)hostAddr != (long)(-1))
   { /* we've got an address */
   bcopy( &hostAddr, &serverSockAddr.sin_addr,
    sizeof( hostAddr ));
   } else
   { /* Ask host database/name server for host entry. */
   serverHostEnt = gethostbyname( serverName );
   if( NULL == serverHostEnt )
   {
   fprintf( stderr, "Can't locate host \"%s\"\n", serverName );
   goto egress;
   }
   /* Copy address from host entry to socket structure. */
   bcopy( serverHostEnt->h_addr, &serverSockAddr.sin_addr,
    serverHostEnt->h_length );
   }
   serverSockAddr.sin_family = AF_INET;
   serverSockAddr.sin_port = htons( port );

   /* Create a socket. */
   toServerSocket = socket( AF_INET, SOCK_STREAM, 0);
   connect( toServerSocket, &serverSockAddr,
   sizeof( serverSockAddr) );
   result = toServerSocket;

egress:
   return result;
} /* connectToServer */
```

Listing 5: *The client process.*

```
#define Port (ushort)13760 /* that widely known socket port
    number */

void main( void )
{
   int toServerSocket = -1;

   /* Try to connect to a server. */
   toServerSocket = connectToServer( svrName, Port );

   /* Communicate with server */
   .
   .
   .

   /* When done, tell server to terminate process. */
   .
   .
   .

   if( toServerSocket >= 0 )
   {
   shutdown( toServerSocket, 2 );
   close( toServerSocket );
   }
   return result;
} /* main */
```

the network communication to terminate. If the value is 0, then further receives are disallowed. If the value is 1, further transmission is disallowed. If the value is 2, both sends and receives are disallowed. In our case, since we are done with all communication, we select 2. Once all sends and receives are shut down, `close()` needs to be called to release any system resources the socket may have required.

Now that we've got a server, we need to create a client that can use its services. The client program in listings 4 and 5 is simpler than the server. As with `createService()` for the server, we gathered the initialization routines into a single function, `connectToServer`, which takes the server's host name or address and a port number and returns a socket value that is used for further communication.

The only tricky part of `connectToServer()` is that you need to be able to locate the machine on which the server is running. As with ordinary file I/O, you then use write and read functions to exchange data with the server. When the client is ready to end the session, it calls `shutdown()` and `close()`.

Socket to 'Em

The full programs from which we drew these examples are available in electronic format (see page 5 for details). We developed the test programs under MS-DOS 5.0 using the PC/TCP Development Kit from FTP Software and Microsoft C 6.00a. We then ported the programs to SCO Unix System V without a single code change.

The client operates under both DOS and Unix. The server program will not execute under DOS, since DOS is not a multitasking environment. However, you could build a single-task server under

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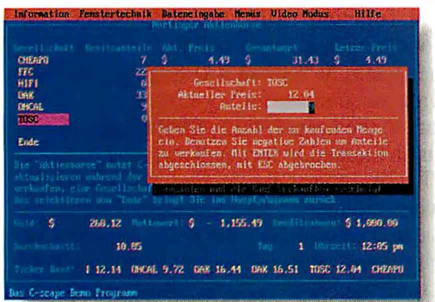
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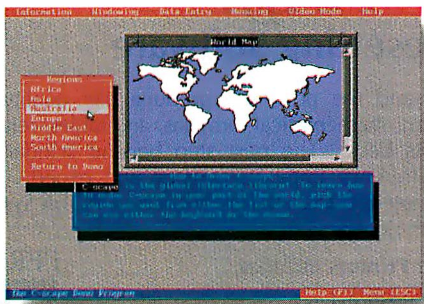


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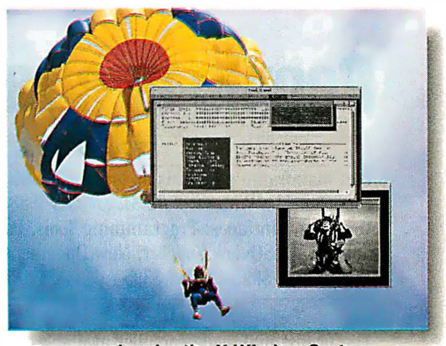


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Once we have a server, we need to create a client that can use its services.

DOS and communicate to it from another system.

Stream sockets are not the only kind of sockets that you might want to use across a network. And sockets are not the only way to handle IPCs across a network. There are other IPCs for other networks, but sockets are the most widely implemented ones.

The sockets mechanism was initially introduced in BSD 4.2 Unix in 1981. That implementation provided sockets as system function calls; in other words, sockets were built into the BSD kernel. Unix System V release 4.0 employs the streams mechanism for hooking external drivers to the kernel; thus, SVR4 sockets are implemented in terms of streams.

What is impressive is that the same source code that we have provided here can be compiled with little or no modification on any of these disparate systems and implementations, and the sockets work across these different worlds. This is an illustration of reliable IPCs in a truly heterogeneous computing environment. ■

ACKNOWLEDGMENTS

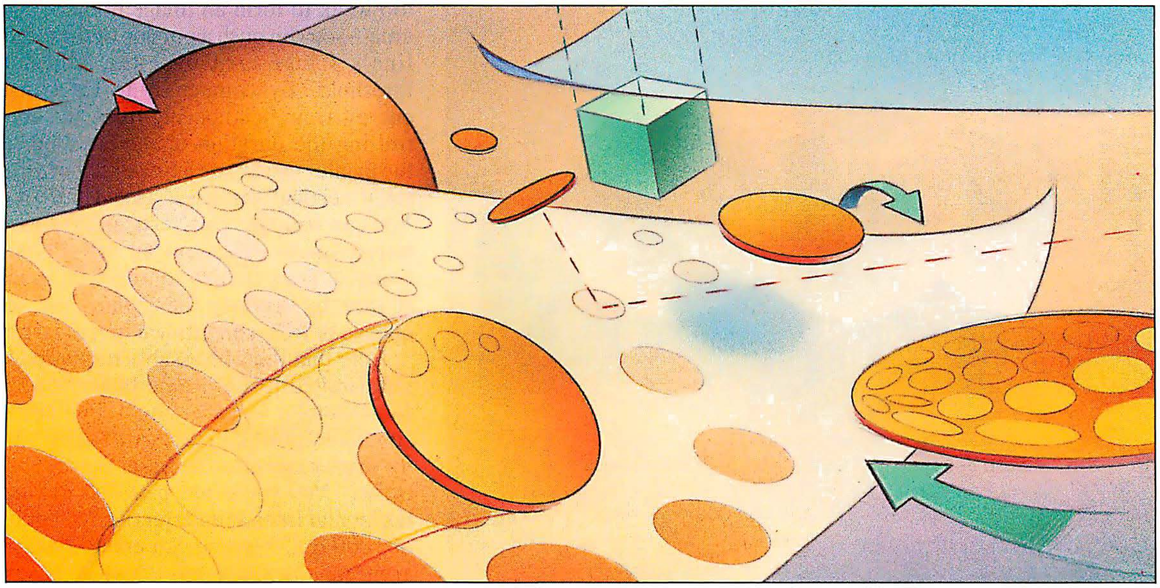
We wish to thank Tom Yager for all his help and also chapter 5 of his book UNIX Program Design and Development for IBM PCs *(Addison-Wesley, 1991), which gave us a jump-start into the world of TCP/IP programming.*

Raymond G A Côté, a testing editor for the BYTE Lab, is a certified Macintosh developer. You can contact him on BIX as "rgacote." Ben Smith is a BYTE technical editor and author of the book UNIX Step-by-Step *(Howard W. Sams, 1990). You can contact him on the Internet as "ben@bytepb.byte.com" or on BIX as "bensmith."*

Your questions and comments are welcome. Write to: Editor, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458.

BRADLEY DYCK KLIEWER

ENHANCING LASER-PRINTER RESOLUTION



The hottest laser battle going has nothing to do with the world of science fiction. But you could still say that it's in the realm of special effects. How can you make the eye see smoother lines and better halftones? Laser-printer manufacturers are tuning their engines so that they can produce pages with effective resolutions beyond the familiar 300-dot-per-inch limits. I'll look at some of the techniques that companies like Apple, DP-Tek, Hewlett-Packard, LaserMaster Technologies, and XLI use to achieve these effects.

There are two general approaches to resolution enhancement: edge smoothing and gray-scale enhancement. The former approach includes Apple's FinePrint, DP-Tek's Super Smoothing Technology (SST), HP's Resolution Enhancement Technology (RET), and LaserMaster's TurboRes. Gray-scale enhancements include Apple's PhotoGrade, DP-Tek's LaserPort Grayscale controller, and XLI's Super LGA.

For most people, laser printers are synonymous with quality and precision. Relative to what a dot-matrix printer can do, a laser printer produces amazingly sharp, consistent output. But, if you look closely, you can still see the jagged edges along sloped lines and curves. If you magnify the pixels, you will see that they are not perfectly round. You may also see stray specks of toner around the edges and between pixels. These imperfections are a consequence of the indirect nature of laser printing.

The direct imaging process that phototypesetters use exposes light-sensitive paper, or *film*, to a light source such as a laser. Responding to small variations in the light intensity, this process produces images that are extremely sharp. Resolution is typically from 1200 to 2400 dpi.

Thanks to an assortment of clever techniques, standard laser printers are producing sharper vector graphics and more photo-realistic images

Laser printers, by contrast, use an indirect process. The laser exposes a light-sensitive print drum and creates an electrically charged image on the drum's surface. Toner particles receive an opposite charge, so they are attracted to the image that the laser forms. The printer engine then transfers the image to a piece of paper and fixes it in place by heat fusion.

Basic Theory of Resolution Enhancement

How can this process be tweaked to boost resolution? Within limits, you can reliably modulate the laser at a higher clock rate than the default for a 300-dpi printer, thereby boosting the horizontal resolution beyond 300 dpi. The higher horizontal resolution improves the shape of nearly vertical edges but does little for those that are nearly horizontal. Most laser printers conveniently provide a video I/O port through which an

ILLUSTRATION: AKIO MATSUYOSHI ● 1992

external controller card can directly regulate the laser modulation.

Vertical resolution is a different kettle of fish. It's controlled by the interaction between the drum and a rotating mirror, which creates the scan lines. In a typical laser-printer engine, there are 300 scan lines for every inch of travel; therefore, the vertical resolution is fixed at 300 lines per inch (400- and 600-lpi engines are also available). Theoretically, you could make mechanical alterations to existing printers to control vertical resolution. However, the complications and expense of such modifications make this approach impractical. Instead, strategies for enhancing vertical resolution exploit quirks of the printing process.

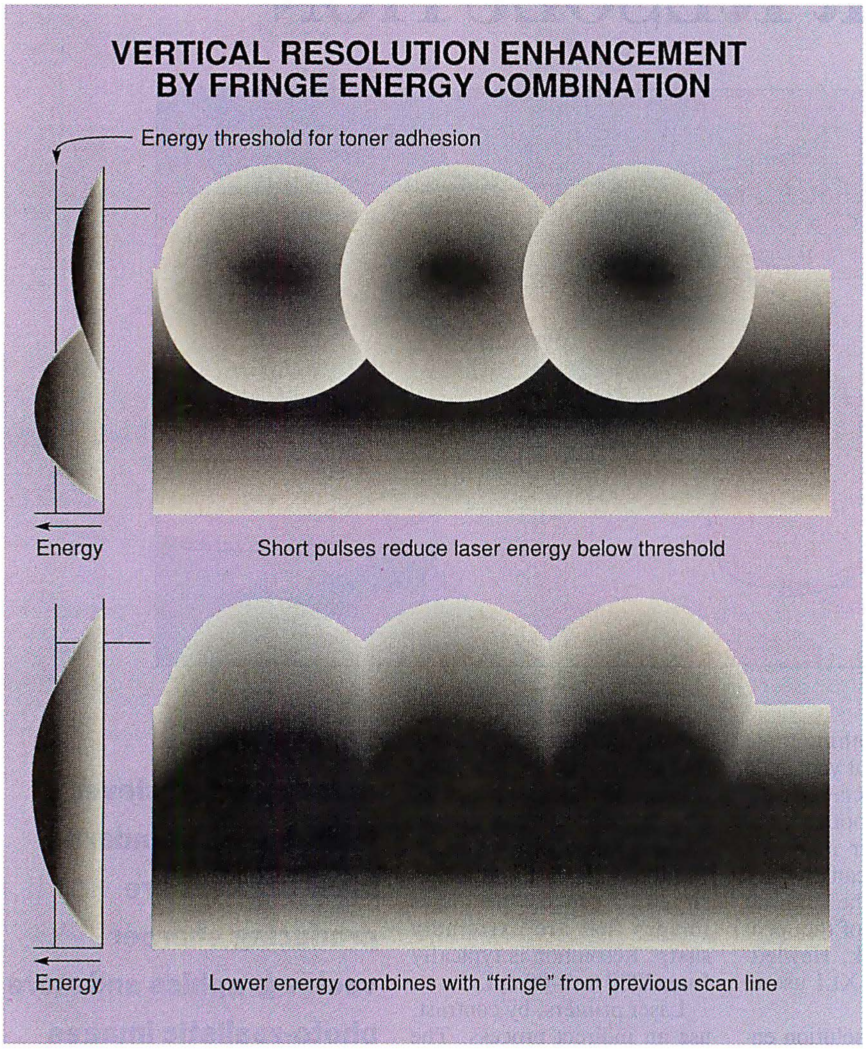


Figure 1: *A weak pulse of laser light on the upper scan line combines with fringe energy delivered to the lower scan line to fatten the line. The upper part of the diagram shows an ideal situation in which the two scan lines do not interact; the lower part shows the actual, combined effect. (Courtesy of LaserMaster Technologies)*

Listing 1: *Simulating vertical resolution enhancement on a PCL printer.*

```
[Esc]*t300R
[Esc]&l.16C[Esc]*r0A
[Esc]*b16WUUUU[255][255][255][255][Esc]*b16W[255][255][255][255][255][255][255][255]
[Esc]*rB
[Esc]&l8C
[FF]
```

At the fringes of the laser's beam, the intensity drops off, much like a flashlight's beam, which has a bright center spot surrounded by a dimmer halo. The region of the drum under this fringe area doesn't receive enough energy to make the toner stick to the drum. However, if you augment the fringe area's charge with a brief pulse of laser light on a preceding or following scan line—a pulse too weak to form an image in the fringe area—you can push a portion of the target line's fringe area over the adhesion threshold. By compensating for fringe energy from neighboring lines and controlling the duration of the laser burst, the printer can create a line or dot of arbitrary vertical thickness (see figure 1). You can simulate this vertical resolution enhancement effect on an HP Printer Control Language-compatible laser printer by sending the printer the sequence of PCL code shown in listing 1.

Note that the addressable resolution is still limited to the frame buffer's size; for example, consider the 1000- (horizontal) by 400-dpi (vertical) frame buffer implemented in the LaserMaster controller. You could not plot 500 distinct horizontal lines at an effective resolution of 1000 dpi. But you can create lines of arbitrary thickness and therefore have a higher effective vertical resolution along the edge. By gradually tapering the line thickness while moving horizontally, you can form an edge with steps of finer granularity than that of the frame buffer. The effective resolving power can be nearly continuous, limited more by other factors (e.g., toner particle size) than by laser-modulation rates.

DP-Tek takes a different tack with its TrueRes technology. TrueRes doubles both the horizontal and vertical resolution and gives you access to each pixel through a 600- by 600-dpi frame buffer.

Make Way for Gray

Because a laser printer can print only black or white, gray areas in images (e.g., photographs) must be approximated with patterns of black and white. Laser-printer enhancement technology uses two approaches. The first technique, exemplified by DP-Tek's LaserPort Grayscale controller, modulates the laser to produce an even spray of toner over an area. The density of the toner determines the gray level. The resulting images resemble photographs and are particularly well suited to direct production of photo-realistic images. However, the detail is too fine for reproduction on

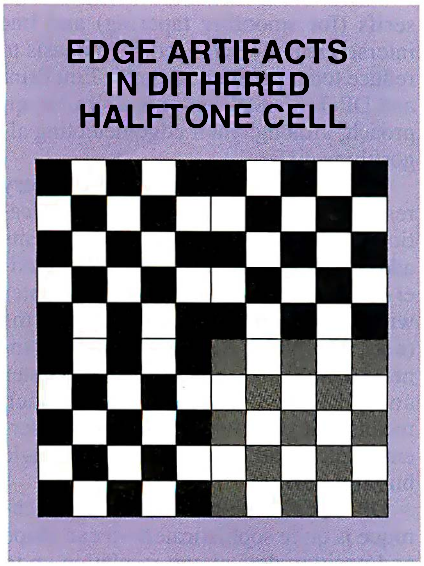
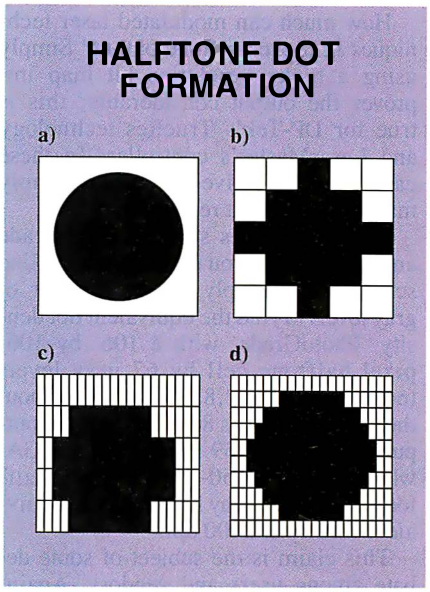


Figure 2: *Pixel doubling makes the edges of this dithered halftone cell stand out.*

Figure 3: *Both horizontal and vertical resolution enhancement benefit the precision with which a halftone dot can be formed. The figure shows* **(a)** *an ideal halftone dot,* **(b)** *a halftone dot emulated at 300 dpi,* **(c)** *a halftone dot improved with horizontal resolution enhancement, and* **(d)** *a halftone dot improved with both vertical and horizontal resolution enhancement.*



an offset printing press.

The other technique is called *halftoning*. When you output a bit map to a PCL printer, the application typically creates dithered halftone cells that behave like metapixels. Within each cell, the number of pixels that are on (black) or off (white) determines the gray level of the cell (see figure 2). There will be n^2+1 gray levels, where n is the number of pixels along one side. As you increase the gray levels, you get a more realistic selection of gray shades, but you lose resolution. This resolution, the number of halftone cells per inch, is called the *line screen*. It is measured in lines per inch.

If you are reproducing your work on a printing press, it is important to select the appropriate line screen; for example, in a newspaper, 65 to 85 lpi is fairly standard. Other presses used for magazines and corporate brochures print at screen resolutions of from 133 to 200 lpi.

PostScript printers cluster pixels in a cell to emulate a halftone dot. Figure 3a shows a cell with a 50 percent halftone dot, and figure 3b shows one possible emulation of that pattern at 300 dpi. You can alter the cell's fill pattern to change the effect, or you can rotate to change the screen angle.

Complexities of the Halftone Process

The task of producing good halftone output is fraught with complications. What prints well on a laser printer may not reproduce so nicely on an offset press. The number of pixels in a halftone cell—whether evenly dithered or dot-clustered—determines the gray level. Given a specific line screen (60 lpi) and the printer's resolution (300 dpi), you can calculate the size of the halftone cell—in this case, 5 by 5 pixels. A 50 percent gray level would fill half of these cells (i.e., 12 or 13).

But which 13 cells should be filled? With straight dithering, the resulting gray level will have a fairly even tone, yet a cell may exhibit artifacts. In figure 1, for example, the edges of the cell stand out because the pixels meet. This problem could be solved by moving to an even-numbered cell size (e.g., a 4- by 4-pixel cell, or a 75-lpi screen). But this approach introduces yet another problem. When printed on an offset press, the cell behaves like a 212-lpi screen—the alternating pattern (at 300 dpi) creates rows of pixels at a 45-degree angle within the cell itself—too fine for accurate reproduction.

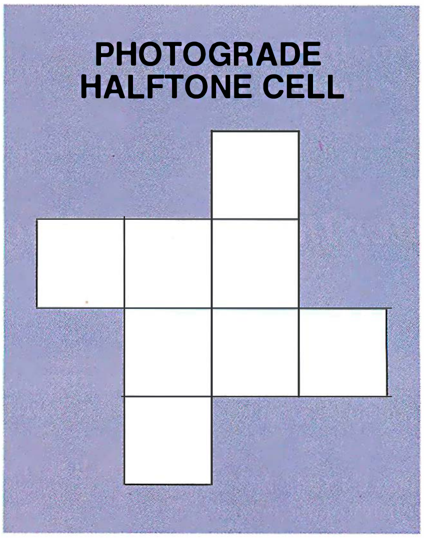


Figure 4: *The unusual shape of Apple's PhotoGrade halftone cell lends itself to efficient calculations and speedy rendering.*

Halftoning with Resolution Enhancement

Resolution enhancement gives you the opportunity to emulate a halftone dot more precisely. Figure 3c shows what the LaserMaster controller can do. Because it's pixel-addressable along the x-axis, horizontal resolution enhancement improves the shape of the emulated dot. XLI's Super LGA technology goes a step further: It applies both horizontal and vertical enhancement techniques to the formation of the halftone dots (see figure 3d). As a result, even more gray levels are available than through a simple horizontal resolution boost.

In some cases, the halftone cell may not be square. Apple uses a rather unusual shape with PhotoGrade. The default cell pattern for PhotoGrade (see figure 4) results in a 45-degree, 106-lpi screen with 67 gray shades. The shape looks somewhat odd, but Apple claims that it lends itself to efficient calculations, thus improving rendering speed.

Halftone imaging can dramatically cut data-storage requirements. Consider a 16- by 16-pixel halftone cell. Such a cell supports 257 shades. If the pixels were stored individually as a bit map, they would require 256 bits, or 32 bytes of memory. When converted to a halftone cell, the same image area can be stored as a single byte, because 256 gray levels can be described by one 8-bit selector. That's a dramatic reduction in memory requirements.

continued

How much can modulated laser techniques improve halftone output? Simply using a higher-resolution bit map improves the output considerably; this is true for DP-Tek's TrueRes technology and LaserMaster's controller. In these cases, the effective resolution simply matches the output resolution.

With techniques such as PhotoGrade and Super LGA, you must square the line screen and multiply by the number of gray levels to find the equivalent dot density. PhotoGrade, with a 106- by 106-pixel halftone cell by 67 gray levels (equivalent to 752,812 dots), has about the same density as 867-dpi dithered output (867^2=751,869 dots). Super LGA, which claims a 150- by 150-pixel halftone cell by 256 gray levels, has an equivalent density of 2400 dpi.

This claim is the subject of some debate among users and vendors. Again, due to the indirect nature of the process, a region of dark grays may saturate to black. Similarly, light areas may not meet the threshold and print white. In other mixed areas, the interaction allows additional detail to appear, and the resulting images are quite impressive.

Different Strokes for Different Vendors

Laser modulation is now quite common for vertical resolution enhancement. But the implementation can vary significantly from company to company. One difference lies in where the resolution enhancement is processed—before or after the image is rasterized (i.e., converted into a pixel-by-pixel image). For example, LaserMaster, one of the pioneers in vertical resolution enhancement along edges, stores data as idealized images. This technique reduces the memory demands on the frame buffer. As each character prints, the TurboRes algorithm applies the ideal image shape to the real-time rasterization process. Hence, a stroke of fractional width can be rasterized as a fractional width.

HP's widely recognized RET takes the other tack. RET alters the image after it has been rasterized. The printer stores six lines of data and compares the pattern formed by each pixel and its nearest neighbors to known edge patterns. If a match is found, the printer modulates the laser to smooth the edges. Stored patterns include objects such as serifs (for smoother tapering) and line intersections (which need deemphasis to reduce toner pooling). Apple's FinePrint and DP-Tek's SST both use a similar approach, although their edge-detecting algorithms differ.

Where does the enhancement circuitry reside? Apple and HP make modifications to the printer. These enhancements add to the appeal for a particular model—and you can use the same printer with any number of hardware platforms (e.g., Macintosh, ISA, and Micro Channel architecture systems). LaserMaster and XLI supply add-in cards, which means that you can upgrade many different printer models but are tied to a single bus architecture.

DP-Tek's TrueRes modulation technique is quite sophisticated—it can shape and position dots at any resolution up to double that of the native engine. By combining this effect with pixel-by-pixel addressability, TrueRes can reproduce odd resolution images, such as a fax (203 by 98 pixels or 203 by 196 pixels) or 240 by 240 pixels (a fairly standard resolution in Japan). These features are available in chip sets that laser-printer

vendors can purchase. The individual vendors then market a modified engine that competes with HP and Apple by adding value to the printer. TrueRes is also available in the form of a separate controller called TruePoint, so you can use it to upgrade existing laser printers.

LaserMaster emphasizes master-page production for offset printing, where clean edges and faithful reproduction of type is important. TurboRes claims a 1000- by 1000-dpi resolution, although the continuous nature of vertical enhancement allows much finer vertical control. As of this writing, LaserMaster does not store bit-mapped data in a halftone format. Instead, the company uses a dithered frame buffer that matches the vertical scan density of the engine (400 lines for its own hardware) and boosts the horizontal resolution to 1000 dpi. LaserMaster's dithering algorithms faithfully reproduce variable line screens and angles. It supports both PC and Macintosh platforms. The company also supplies adapters for 300-dpi laser printers, as well as its own printer, which uses a 400-dpi engine.

By the time you read this, LaserMaster will have announced an upgrade called TurboGray that applies TurboRes vertical-resolution enhancement techniques to halftone images. By preprocessing several formats (e.g., PostScript and PCL 4), LaserMaster controllers can apply the proper enhancement technology to the right image—edge or bit map.

Whereas LaserMaster stresses edge enhancement and applies dithering methods to halftone images, XLI enhances halftone images with shaped (i.e., vertically enhanced) dots. As of this writing, XLI does not enhance text, although such a feature should be available by the time you read this. XLI produces an OEM product that combines other edge-enhancement technologies to text.

XLI's Super LGA technology is embodied in the company's LaserPix controller, which targets Microsoft Windows applications. When a Windows application sends output to the printer, the LaserPix grabs the gray-scale images and processes them through the laser printer's I/O port. Meanwhile, other data continues through the parallel or serial connection. By synchronizing the I/O transmission with the drum motion, the LaserPix can add the enhanced images while the page prints. If the laser printer supports edge smoothing (as the LaserJet Series III does), your output can have the combined enhancements of both technologies.

The LaserPix controller provides only two screens: 75 lines at a 63-degree angle and 150 lines at a 0-degree angle. Both screens use 256 gray levels. For most offset printing, 150 lines is too fine. XLI has targeted this resolution for use in imaging applications, where direct output is useful or economical; for example, medical imaging and electron microscopy often use expensive Polaroid cameras to capture images. With the LaserPix, you can use a laser printer as a fairly inexpensive substitute for photographic reproduction.

Print speed is also emphasized with the LaserPix. Indeed, screen selections have been limited to optimize the rasterization algorithms. The controller transfers images to the printer much faster than a parallel or serial port. As long as the print run is fairly small, the system is useful for multiple copies.

Apple includes edge and gray-scale enhancement on its printers. FinePrint provides the edge enhancement, and PhotoGrade improves gray-scale images. These technologies are available in the new LaserWriter IIF and IIG Grayscale printers.

Apple uses a mix of pre- and postprocessing to keep PhotoGrade and FinePrint from interfering with each other. The FinePrint postprocessing circuitry recognizes the PhotoGrade format and turns itself off when a bit-mapped image is processing. Earlier, I showed you that PhotoGrade uses 67 gray shades—a seemingly strange choice, since that works out to 8.375 levels per pixel. Why not an even 8 or 9 levels? Due to variations in physical properties (e.g., toner particle size), what may appear as subtly different shades of gray in one print run may appear as the same shade in the next run. Apple's experiments showed that 67 levels per halftone cell was a practical maximum for consistent results. In fact, the PhotoGrade format allows for 16 levels per pixel (or 128 levels per cell), so Apple is leaving room for expansion.

Pushing Laser Printers to the Limit

Apple is taking a conservative approach in limiting its gray scale to 67 shades. It is possible to push the engine to higher effective resolutions, as companies such as XLI are doing. But even at claimed effective resolutions of 2400 dpi, it would be premature to proclaim the demise of the phototypesetter. Although the effective resolutions offered by these enhancement techniques approach or exceed the levels offered by typesetters, the laser-printer images are not as sharp. The interaction between toner and drum and even gear noise from the paperfeed mechanism (which appears as dark bands on the printout) limit the clarity of plain paper output.

Nevertheless, many applications do not require the full clarity of phototypesetter output. Enhanced laser-printer output offers a marked improvement over standard 300-dpi printing. Certainly, there are many people who use 300-dpi pages for camera-ready output. For these users, resolution enhancement offers a cost-effective path to higher quality. You can also directly use the plain paper output of a laser printer for applications as simple as correspondence or as complex as small-volume production. With the various enhancement options available, you can select a price and features that are appropriate for your specific task. ■

Bradley Dyck Kliewer is the principal of DK Micro, a PC and AS/400 consulting firm in Minneapolis, Minnesota. He is author of EGA/VGA: A Programmer's Reference Guide, *2d ed. (McGraw-Hill, 1990), and he can be reached on BIX as "bkliewer."*

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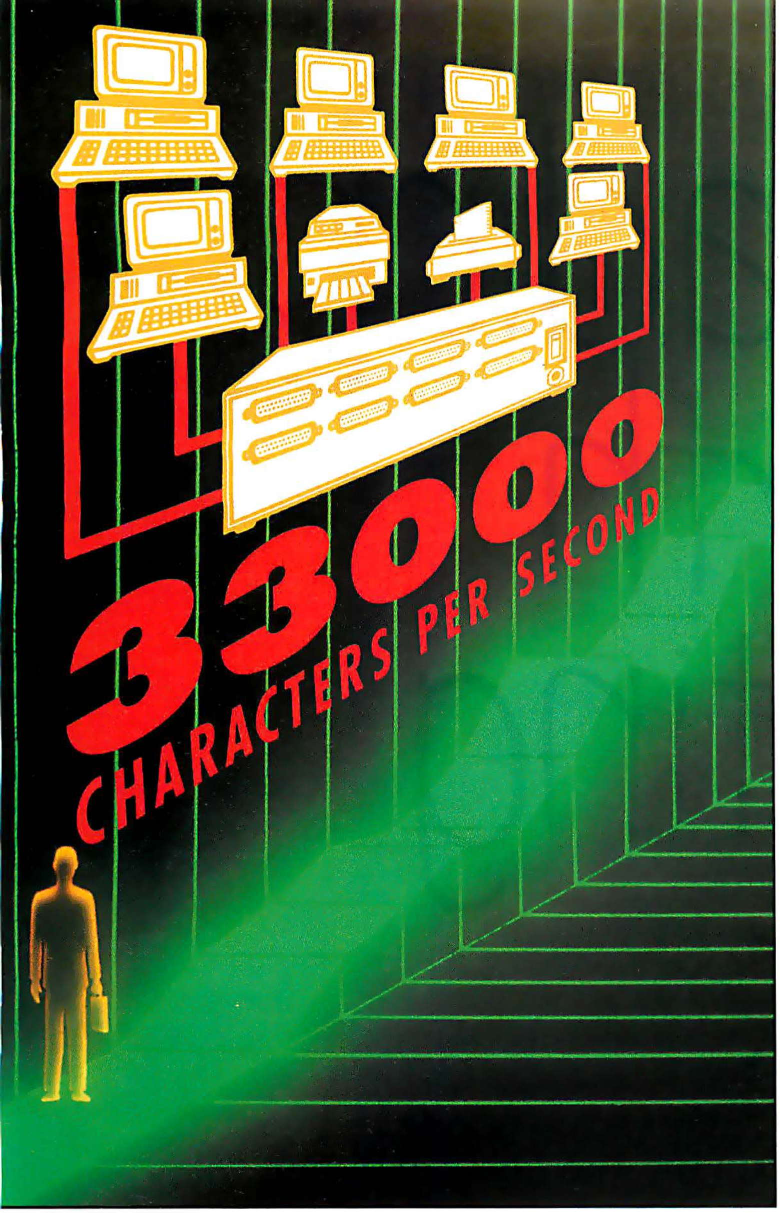
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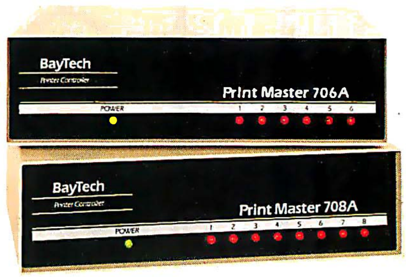
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BARRY NANCE

NETWORK SLEUTH

The PC program this month is QVersion, a NetWare utility that tells you configuration information for each user. QVersion will help when you install the new version of the NetWare NetX.COM shell program. NetX 3.3 fixes a bug described in my December 1991 NetWorks column ("The Black Art of Networking").

The problem was that local buffering of files within NetX sometimes lost data before it could write it to the file server. If you're using version 3.01E through 3.22 of the NetX shell, contact your NetWare dealer for the free upgrade to version 3.3.

You can ask that all users on your network install the new version of NetX in their machines, but how can you tell who followed instructions? QVersion lets you quickly survey your entire LAN to ensure that everyone is using up-to-date network software. It displays each user's log-in name, Internet Packet Exchange (IPX) and NetX versions, network address, adapter ID (i.e., node address), and last log-in date and time. If you have console operator rights, you can use the program if you install it in the "public" directory on your file server.

QVersion lets you quickly discover any NetWare user's network configuration

Run QVersion to see the status of all nodes. To see one user's configuration, type QVERSION followed by that user's log-in name. You need type in only the first few letters of the log-in name; QVersion will do the rest. The program doesn't scroll output, so be sure to type `QVERSION | MORE` to view the results one screen at a time, or type `QVERSION < FILENAME` to send the output to a file.

Behind the Curtain

QVersion is freeware. I wrote it in Turbo C and included the source code.

You don't need a separate third-party function library to do network programming. QVersion is self-contained. The `int86x()` call returns an entry point that you use to communicate with (and through) IPX and NetX. QVersion stores the entry point in a far-pointer-to-a-function data item. The utility performs IPX/NetX operations merely by invoking the function.

QVersion first looks for active (i.e., logged-in) nodes by using a `GetConnectionInformation()` function call for each connection number. This call returns the user ID and log-in time (the same information displayed by NetWare's Userlist utility). QVersion sends a diagnostic query packet to each active workstation with a `SendIPX()` call. It uses a `GetInternetworkAddress()` call to obtain the network number and node address. The `GetLocalTarget()` call tells QVersion if the `SendIPX()` packet must cross one or more bridges on its way to the other node.

QVersion next sets up a special diagnostic sequenced-packet-exchange session with the target workstation and requests the IPX and NetX version. It stores the returned IPX and NetX version data, terminates the SPX session, displays the results, and moves on to the next workstation. ■

UNIX/Ben Smith

Mail Prep Made Easy

The freeware programs uuencode and uudecode are quite simple utilities that prepare binary files for transfer over Unix mail systems. Although simple, they have become standard utilities found throughout the Unix community. If they aren't already on your Unix system, they should be.

Unix mail systems transfer and store messages only as text files, despite the fact that the UUCP system can transfer binary files. The uuencode program generates a map of the binary file using only the printable 7-bit characters. By using some clever bit-shifting, developer Mark Horton is able to use only four ASCII characters to represent 3 binary bytes. Counting the extra overhead of a header, a trailer, and the end-of-line character in every 45-character line, the net increase is only 35 percent. A hexadecimal dump would require a 100 percent increase in file size. The uuencode and uudecode programs make it possible to send binary files as mail messages.

MAC/Tom Thompson

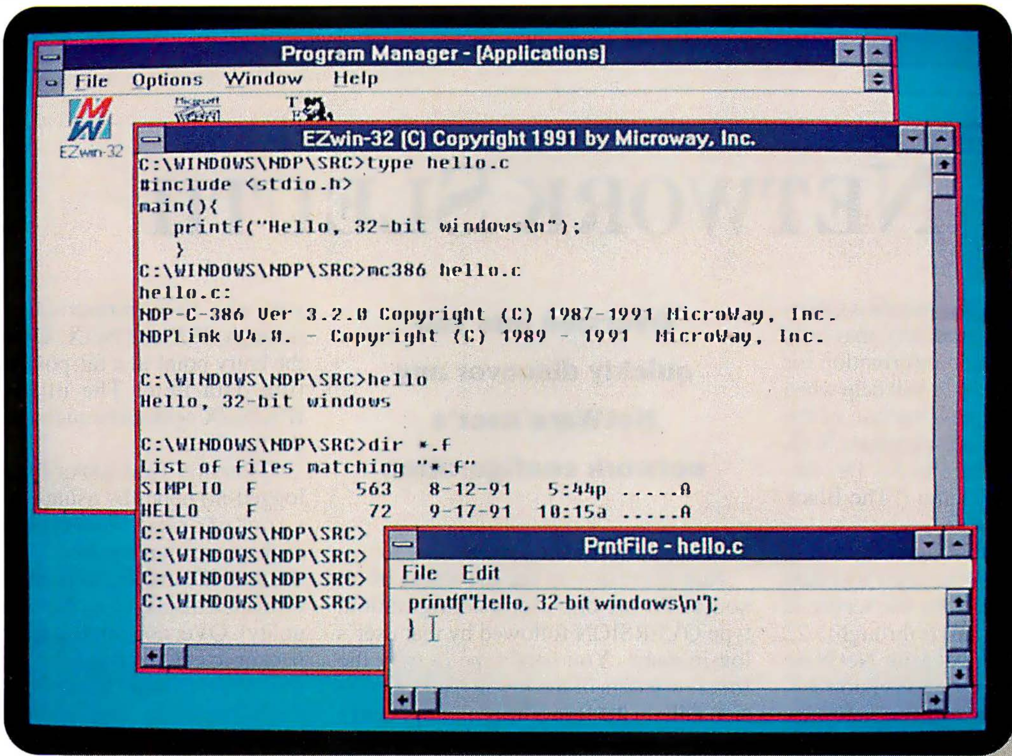
BroadCast Gets the Message Out

BroadCast is a shareware program written by Joachim Lindenberg, a German Mac programmer. It is an elegantly simple Chooser-selectable RDEV that lets you transmit up to 255-character messages and replies to other networked Macs. The recipient, who must run BroadCast, hears a chime tone and sees a message window on-screen. The recipient can dismiss the window or type a response. The All button lets you send a public message to all users.

BroadCast is network savvy. I've sent messages from a Quadra and a Mac IIci in an Ethernet zone through a GatorBox to Macs in a LocalTalk zone. BroadCast works with AppleTalk Remote Access, which lets you leave messages on the screens of office Macs from a PowerBook in the field. BroadCast costs $25 for each zone or $100 per network. Registered users get a Unix version of BroadCast that lets Macs and Unix workstations communicate.

Editor's note: *Software Corner programs are available in a variety of formats. See "Program Listings" on page 5 for details. We solicit your contributions for this column. If you've written a program or utility that you think others might find useful, let us know. We'll pay $50 for any program we use. Write to: Software Corner, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458.*

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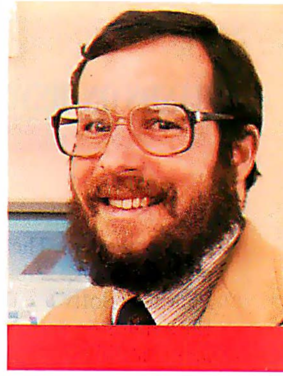
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MARTIN HELLER

32-BIT WINDOWS TODAY

Software developers use DOS extenders—and now, Windows extenders as well—to create 32-bit programs that speed up computations on large arrays or large images. For instance, 32-bit versions of AutoCAD are noticeably faster than the equivalent real-mode DOS versions and much faster than the OS/2 Presentation Manager versions. The architecture of the 386 chip makes 32-bit operations between two and five times faster than ordinary 16-bit operations. This more than balances out any overhead incurred when a DOS extender has to simulate real-mode interrupts to access DOS and BIOS services.

When a 16-bit protected-mode program has to use huge-pointer arithmetic, it incurs tremendous overhead. In real mode, huge pointers juggle segments and offsets. But in 16-bit protected mode, when huge pointers juggle selectors and offsets, juggling selectors means accessing the local descriptor table and all sorts of other rigmarole.

How bad can this be? Worse than you would imagine. I used profiling on one line of C that was looping on a simple assignment with huge addressing in a Windows program. I discovered that it was taking 60 percent of the execution time in a routine to read a graphics interchange format (GIF) image and convert it to a Windows device-independent bit map (DIB). When I rewrote the line to use the `_fmemcpy` function, so that it did address calculations once per scan line instead of once per pixel, it became an insignificant (i.e., less than 1 percent) component of the overall execution time. The next step—converting the program to 32-bit operation—seems like it should net a factor of 2 increase in speed.

Last December in this column, Walter Oney wrote about the technologies available to write 32-bit Windows programs; you might want to go back and read it. I'm not going to cover the technology so much as address the practical aspects of converting a Windows program to 32-bit systems.

32-bit Systems

Both OS/2 2.0 and Windows New Technology (NT) are 32-bit systems with a migration path from Windows. For that matter, Unix with the X Window System and Motif could also be characterized as a 32-bit system with a migration path from Windows. The differences among these systems are vast, but from the point of view of a Windows programmer, the most serious question is "How much rewriting will I have to do?" From the point of view of a marketer, the most serious question is "How many people will pay for our program on this platform?"

These Windows extenders let you create 32-bit programs



It looks like IBM will be providing a 32-bit version of Mirrors (developed by Micrografx) to make it easier to port from Windows to OS/2 2.0. I haven't seen it yet, so I can't comment on how much work will be involved. Microsoft has designed the Win32 application programming interface (API) to be highly compatible with 16-bit Windows, with the exception of the packing of parameters in messages. It looks like most Windows programs will port to NT with a few weeks of effort.

I've found one third-party tool for porting from Windows to Unix with OSF/Motif. It's the Wind/U API Library from Bristol Technology. I understand from the people who ported CorelDraw to Unix that other tools are available.

For all the hype, relatively few people are running any of these systems—they represent niche markets. DOS and Windows are still the bread-and-butter platforms for most PC applications developers. I have compilers and toolkits from Watcom and MetaWare that let me build 32-bit Windows programs for plain old Windows 3.x. They are available now, and they work.

Watcom C/386 and FORTRAN 77/386

Watcom is a spin-off from the University of Waterloo's computer science department. I ran Waterloo FORTRAN and PL/I compilers on an IBM 360/67 in 1972. They were hot compilers then, and Watcom has maintained the tradition.

I currently have version 8.5 of Watcom's C and FORTRAN compilers in both 16- and 32-bit flavors. There is a lot to like about these compilers. Their optimization is rather good. You can combine FORTRAN and C in a single executable file—a real boon if, for example, you have a large library of FORTRAN routines for numerical methods. The 16-bit compilers support DOS, OS/2, Windows, and 16-bit

ILLUSTRATION: TIM GRAJEK © 1992

DOS extenders. The 32-bit compilers support Windows; 32-bit DOS extenders from Phar Lap Software, Ergo Computing, and Rational Systems; Novell NetWare loadable modules; and AutoDesk AutoCAD development system (ADS) applications.

You can install all four compilers in the same directory because they share a common toolkit. The toolkits are pretty complete—linkers, debuggers, profilers, a make utility, graphics libraries, and sample source code to support all those environments. The compilers aren't inexpensive. C/386 is currently on sale for $795, but it normally sells for $995.

I'll concentrate here on Watcom C/386 as it applies to 32-bit Windows programming. Remember that the Windows 3.0 API is all 16-bit calls and callbacks. Watcom supplies a supervisor for the 32-bit environment that is bound with your 32-bit flat-memory-model program linked against special 32-bit Windows and C libraries. The 16-bit application resources, stack, and local heap all reside in the supervisor.

The Watcom Windows supervisor takes care of allocating 32-bit memory and loading your application. It has glue functions so that 32-bit functions can call the Windows API and DOS, and "glue-back" functions so that Windows can call back to 32-bit routines.

Watcom's approach is a valiant attempt to make the transition from 16-bit Windows to 32-bit Windows easy, but a number of areas require rewriting. One problem area is data passed in messages. Windows routinely packs pointers into the long parameter of its messages; these pointers are not automatically converted by the Watcom supervisor. Whenever you have code that casts `lParam` to or from a pointer, you'll have to explicitly convert 16-bit near and far pointers to and from 32-bit pointers.

Some callback functions (e.g., `EnumFonts`) pass pointers that need explicit conversion. You have to do special things to make a procedure instance from a 32-bit function or to call a function for which you got the procedure address. Subclassing is tricky because you have to provide a 16-bit callback address. You can't use the pointers you get from `LocalLock` or `GlobalLock` until you've converted them.

All this memory management stuff can become confusing, especially when you need 32-bit far pointers. It's easy to mess up your pointer conversions. There's also a lot of overhead from the supervisor and its allocation of 32-bit memory. You're talking about 2-MB applications here.

On the other hand, the speed improvement when you get everything working is dramatic. One of the sample applications that ships with the Watcom C compilers is a Windows Life simulation. The 32-bit version—which copies arrays using `memcpy` rather than fooling around with huge pointers and `_fmemcpy`—really flies.

Watcom C/386 has an option to build C programs using standard I/O into 32-bit Windows applications, just by recompiling and relinking. That's one feature that you won't find in the competition.

MetaWare High C Windows ADK

MetaWare had the first 32-bit Pascal and C compilers available for DOS. The company grew up along with Phar Lap in the 386 DOS-extender market. High C got an early reputation as a compiler with good optimization and fussy diagnostics. I bemoaned those diagnostics, the lack of a source-level debugger, and MetaWare's somewhat Spartan C library in these pages several years ago.

continued

I've since changed my opinion of fussy diagnostics: It may be painful to clean your code to compile without warnings, but it's a lot more painful to find errors that slipped through the compiler. MetaWare has significantly improved its libraries and debuggers since then, too. I now have nothing to complain about.

With its latest product, the Windows Application Development Kit (ADK), MetaWare has aimed to make its 32-bit Windows environment better than Watcom's. There are some advantages to bringing your product out second.

In the MetaWare ADK environment, the local heap resides in the supervisor. The difference from Watcom's implementation is that `LocalAlloc` returns a 32-bit far pointer, so you don't have to do any further conversions to use the local heap. However, `malloc` is a better choice than `LocalAlloc`. It allots 32-bit near memory, which can be accessed much faster. MetaWare also redefines standard Windows far data types (e.g., LPSTR) to suit the 32-bit environment.

You still need to explicitly convert some 16-bit pointers to and from 32-bit pointers with the ADK, but not as many as with Watcom C/386. You don't need to worry about converting pointers from `MakeProcInstance` for callback functions. It does the right thing automatically. But you'll have to change some function definitions to satisfy High C's type checking: The message argument to Windows procedures has to be changed from type unsigned to type word.

Another difference between the two products is that MetaWare's supervisor dispatches Windows API calls through a jump table, which is supposed to be faster than Watcom's call-gate implementation. I don't know how important that is. I couldn't see any big speed difference.

Overall, I find it hard to recommend one of these products over the other. MetaWare might require fewer changes in your Windows code for 32-bit operation and has better documentation. Watcom adds the capability to turn DOS C programs into 32-bit Windows programs and supports FORTRAN with C. You won't go far wrong with either choice. ■

Martin Heller develops software and writes about computers, despite a Ph.D. in physics and despite having worked, literally, as a rocket scientist. He is the author of Advanced Windows Programming *(Wiley, 1992). You can reach him on BIX as "mheller."*

Your questions and comments are welcome. Write to: Editor, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458.

ITEMS DISCUSSED

FORTRAN 77/386 8.5 ....$795
Watcom C/386 8.5 ....$795
Watcom, Inc.
(519) 886-3700
Circle 1152 on Inquiry Card.

High C Windows Application Development Kit $395
with High C compiler, 32-bit debugger, and ADK $795
MetaWare, Inc.
(408) 429-6382
Circle 1153 on Inquiry Card.

Wind/U API Library ....$20,000–$200,000
Bristol Technology, Inc.
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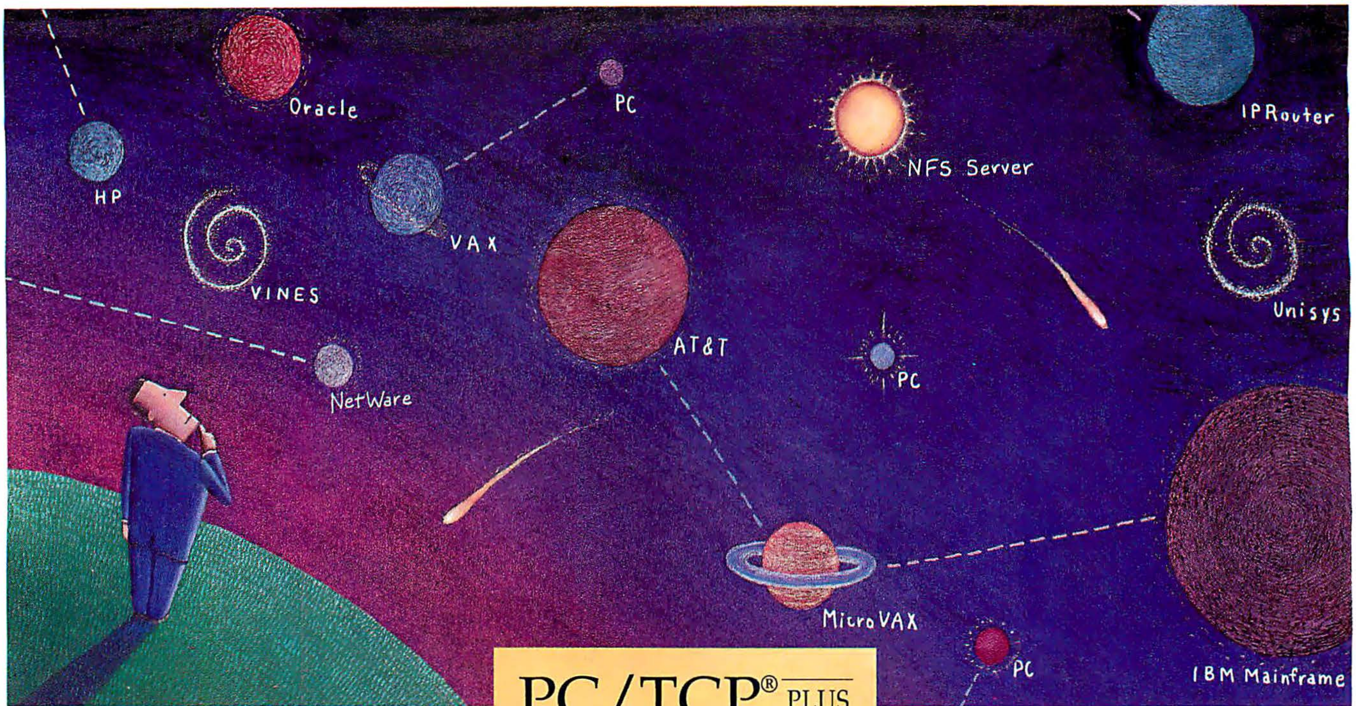
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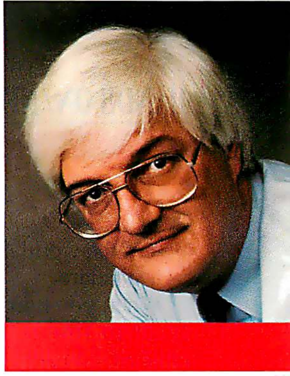
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BARRY NANCE

LAN ANALYZERS MOVE TO AI

If you have a utility or other tool that's indispensable yet frustrating to use, you know how I feel about LAN analyzers. Three companies—Network General, Hewlett-Packard, and Novell—are currently applying AI to their network analyzers to make them easier to use. The technology has a long way to go, but the initial efforts show promise.

You have to be a specialist to use a network analyzer when LAN problems occur. The analyzer captures thousands of packets by eavesdropping on the LAN's message traffic. Looking through this mountain of data to determine the cause of a problem is difficult. Understanding the patterns of what's normal and what's not requires a keen eye and a sharp mind.

A network manager with a protocol analyzer is like a doctor who reaches for a microscope to view cells in a blood sample. The analyzer is the microscope; as the doctor, you have to know what normal cells look like and how many of each type you should see.

Most analyzers consist of a dedicated PC with a special network card and software. They let you look inside network packets and detect specific LAN problems (e.g., a failing device, a configuration error, or a LAN bottleneck). The analyzer selects those frames that meet the filtering criteria you set up, captures them in a file, and summarizes the frames or decodes them to show their contents.

You can tell a network analyzer to show only error frames, frames traveling between two nodes, frames of a certain type or that contain a given pattern of data, or frames that exceed size and frequency thresholds you establish. Some analyzers also let you inject extra traffic on the LAN to simulate adding more nodes.

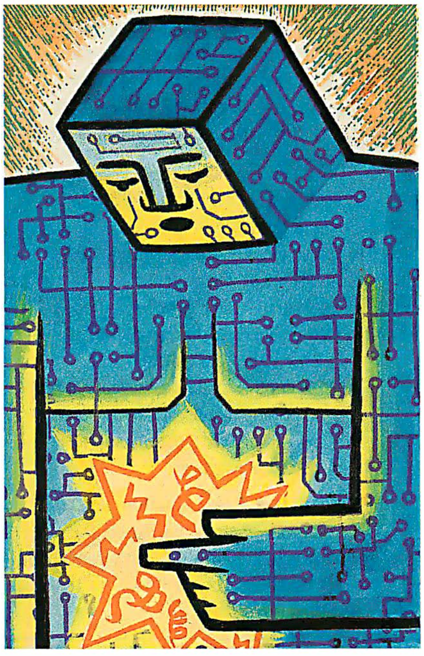
Once you know what to look for, you can use a network analyzer to find the token-ring adapter on your LAN that's causing a broadcast storm, to track routing errors to a misconfigured gateway, or to determine which file server is receiving an inordinate amount of message traffic. It's up to you, however, to plan ahead, note what you're looking for, and concentrate on finding the cause of the problem. Knowing what to look for and where to look are the areas where expert systems can help.

Hewlett-Packard's Network Advisor was the first AI-assisted analyzer to ship. It has a rule-based AI front end called Fault Finder. Network General plans to release Expert Sniffer about the time you read this, and Novell is working on a version of its LANalyzer that uses AI techniques.

First Steps to AI

The Network Advisor consists of a 386-based portable PC with a monochrome or color LCD and a specially designed LAN interface that performs data acquisition. The Fault Finder software, which HP wrote in Prolog, runs on top of DOS and contains more than 100 rules. Its Smalltalk-based GUI can be a bit slow and cumbersome.

Adding AI to analyzers will revolutionize network troubleshooting



At present, Fault Finder can help solve just a few physical-layer problems. On a token-ring LAN, it can monitor for station-insertion failures, hard errors, media-access-control (MAC) beacon frames, congested station receivers, and ring beaconing.

If you ask it to explain itself, Fault Finder can tell you the basis for its reasoning. An example is: "The ring is considered to be beaconing if a station has transmitted eight consecutive Beacon MAC frames."

Solving a few simple problems and providing a few explanations won't justify Network Advisor's $20,000+ price for most users, but it's a start. HP expects to move up the protocol ladder into more complicated scenarios. The list of symptoms you can ask Fault Finder to investigate will eventually grow from "can't connect" to such problems as "sporadic slowdowns," "can't access server 3," and "corrupted server files."

The first Expert Sniffer will also solve about 100 typical physical-layer problems, will recommend the proper actions for a given symptom, and will learn about your network by monitoring network activity. It won't have a fancy GUI, but it will support the widest variety of network protocols. I haven't seen the AI version of LANalyzer, but it will probably offer the most in-depth analysis of NetWare protocols.

Room for Improvement

Like most tools, an analyzer is something you'll use when the situation demands it. You won't spend 8 hours a day, five days a week, operating an analyzer. Therefore, vendors should make the interface compliant with Common User Access (CUA). IBM's user-interface guidelines aren't the

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best in the world, but they are catching on as a standard.

When you hurriedly power up an analyzer to find out why your LAN just crashed, you don't want to have to fumble around with the user interface. A CUA interface, whether text- or GUI-based, will make the analyzer easier to use on an occasional basis.

Vendors also need to make it easier to log onto the LAN from the analyzer, and analyzers should identify network nodes by name as well as by the more esoteric physical address. Even in a problem situation, one or more servers may still be alive and accessible. You may want to print some data on the network's spooled printer. Or, after a problem is solved, you may want to store results on the server. Analyzer manufacturers should supply a variety of preinstalled workstation software.

You need to be able to trust your analyzer. When more than one problem happens simultaneously, and your heart sinks as you get multiple (perhaps conflicting) signals from the analyzer, you need a way to verify its reasoning and its conclusions. The software should let you print out the entire rule base, using clear, simple English sentences. For difficult problems, you'll want to sit back and pore over the rule base as a reference while you search for potential causes. In the same vein, the analyzer must be able to show you, step by step, why it has reached a certain conclusion.

The AI software should let you print the entire rule base, using clear, simple English sentences.

The vendors could print the rule base in the manual, but the rule base should change as the analyzer learns about your LAN. This doesn't happen yet. The analyzer should also let you modify the rule base, in the same way you add new words to a spelling-checker dictionary in your word processor.

The problems you solve will undoubtedly happen to other people. If you had a way (perhaps by modem) to send case histories back to the vendor, and if the vendor had software that digested these scenarios to produce an updated rule base, other users of that analyzer could periodically download a new factory-supplied rule base and learn from your experiences. (You will someday be the other person, by the way.) The analyzer software should keep a record of problems as you solve them, and it should feed these solutions back to a central site.

Finally, LAN traffic doesn't exist in a vacuum. Eavesdropping on the packets as they go by isn't enough. The analyzer should come with diagnostic workstation software that you run at nodes you select and that interacts with the analyzer. The analyzer could control a portion of the LAN traffic to help diagnose problems with specific workstations or particular segments of the LAN.

The diagnostic software should include

a server module (i.e., a NetWare loadable module or value-added process, an OS/2 LAN Server program, or a Unix program). The analyzer could then communicate with both the workstation diagnostic software and the server module to diagnose LAN problems—a sort of CAT scan for your network. With this whole-network approach to finding problems, an AI-assisted analyzer could solve performance problems by locating bottlenecks on the LAN.

The Road Ahead

Eventually, AI-based analyzers will move beyond simple physical-layer maladies to more complex problems. To find out why a LAN is sluggish, you might use an AI-based analyzer to capture frames between specific nodes (e.g., a workstation and a server) and instruct the analyzer to display network utilization, frame counts, and the total number of bytes captured. During analysis, you'd examine when each frame appeared on the network and what that frame contained.

The AI subsystem could help by asking you to characterize the work done by the workstation operator during the test period. It might then correlate that work with the timing of the message traffic for that workstation, taking into account the traffic for other nodes, and help you see why you have a performance problem. If you could load analyzer diagnostic modules at both the affected workstation and the server, you could perform controlled experiments. With the help of the AI subsystem, you could pinpoint a bottleneck, be it a slow server hard drive, insufficient server memory, an inefficient drive controller, a congested network adapter, or some other problem.

Network analyzers are complicated and expensive tools, but they give you a perspective on your LAN traffic that you can't otherwise get. Today's AI-based network analyzers won't help much once you've mastered the basics of using a protocol analyzer.

Tomorrow's products will be more useful in solving more complex problems, perhaps even performance bottlenecks. But don't underestimate the analytical effort you need to expend. It will always be your responsibility to do the deeper analysis to determine what the analyzer's conclusions and recommendations mean to your LAN. ■

Barry Nance is a contributing editor for BYTE. He manages a 70-node NetWare LAN, and he is the editor of the IBM Exchange and moderator of the lans conference on BIX, where you can reach him as "barryn."

Your questions and comments are welcome. Write to: Editor, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458.

ITEMS DISCUSSED

Expert Sniffer .... N/A
Network General Corp.
(415) 688-2700
Circle 1149 on Inquiry Card.

AI LANalyzer .... N/A
Novell, Inc.
(408) 434-2300
Circle 1150 on Inquiry Card.

Network Advisor ... $20,300 and up
Hewlett-Packard Corp.
(719) 531-4000
Circle 1151 on Inquiry Card.



DAVID FIEDLER

X Hits the Spot

Setting up your X and Motif environment, and why to bother doing it

In the last episode, I had just managed to get my PC (running DOS) talking to a Unix workstation via Ethernet, TCP/IP, and Telnet. Flushed with this success, I immediately made plans to simultaneously expand my network and contract my bank account.

When the smoke cleared, I was left with a pile of receipts and several computers. My trusty, once-state-of-the-art 16-MHz 386DX machine, filled to its personal limit of 4 MB of RAM, was relegated to the back room, where it will perform tasks that DOS emulators running on Unix find impossible. Wanting to see if there truly was life beyond MS-DOS, I tried Digital Research's DR DOS 6.0.

Even I Run DOS Sometimes

I am very happy with any product that doesn't require opening the manual, and DR DOS more than qualified. I tested it on four different machines, and it chose reasonable defaults, based on the CPU, RAM, and other hardware it found available during installation.

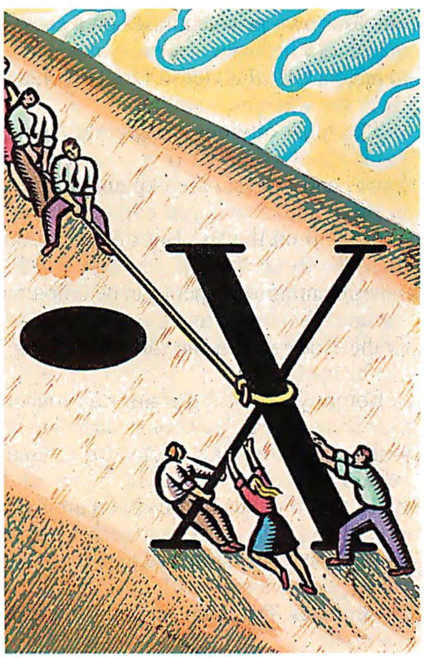
The real reason I wanted DR DOS was for its disk compression, because I didn't want to put any more money into the ancient disk technology existing on this particular machine. Under MS-DOS 3.2, I was forced to set up separate 32-MB (drive C) and 8-MB (drive D) partitions on the 40-MB drive, and drive C had 26 MB used. After installing DR DOS, I have 33 MB of free space on drive C, and I still have a drive D, although it's now twice as big as before. This capability alone makes me think that DR DOS 6.0 is a logical upgrade from MS-DOS... any version.

So the relevant question is, Why doesn't someone write a compressing disk driver for Unix, using similar technology? With compression built into the kernel, you could run your root file system in regular mode for compatibility and mount user file systems that would be compressed, on the fly, to and from the disk. There's a minor performance hit, but one that I consider well worth it for a 150 percent to 300 percent compression ratio.

Up, Up, and Away

To keep my system stable while upgrading it, I decided to keep all my old boards and disks and upgrade the motherboard to a more modern 386 running at 33 MHz with a cache. I wanted to be able to use SIMMs for easy RAM expansion. To hold down costs, I built it myself.

There's a chain of Domino Computer Stores ((510) 226-1800) here in northern California, where you can go in and select your motherboard, case, RAM, and other options from a competitively priced "à la carte" menu. Then you sit down at a static-safe bench with an electric screwdriver and go to work.



With my now much-faster main system humming away, I went out and bought a 486-based workstation, so I would have something to network to (and run X Window System, Motif, and Open Desktop software on). I'm still waiting for some more network goodies to show up, but I did manage to hook my workstation to the Mobius workstation (mentioned last month) without blowing anything up.

Starting X

The start-up procedures for X and Motif are complex enough to rate some mention. There are two ways for X to initialize. Using the `startx` program, you log in as a normal "text" user and can switch to X at any time. You can also set up the `xdm` program, which is a display manager that puts the selected display or multiscreen directly into graphics mode, from which you log in and enter X immediately. If you have X terminals, `xdm` is also useful, because they work only in graphics mode.

If you run `startx`, it first consults a `.startxrc` file in your home directory to find out which X clients (i.e., X-oriented application programs) you want to begin running with. My `.startxrc` file looks something like the one found in listing 1.

The `startx` program itself is just a shell, which calls `xinit`, which then runs the X server (i.e., the program that runs the display). The `xinit` program can use two home directory start-up files called `.xinitrc` and `.xserverrc` (see below). The `xdm` program has a similar start-up file called `.xsession` for launching clients.

Your Own Private Idaho

Have you set up your log-in environment so that whenever you log in, everything is just the way you like it? Or maybe you'd like to set up your log-in this way, but you've never found the time. In either case, let me warn you: If you think developing all your favorite `ksh` or `csh` aliases took a

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Listing 1: *A sample* .startxrc *file. This is the same idea as* .xinitrc.

```
/usr/bin/X11/xrdb .Xresources
mwm 2>/dev/null &
xdt -iconic -geometry 600*222-0-0 2>/dev/null &
odtterm -blink -T 'uname' -j -ut -geo 80*25+0+0
```

Listing 2: *A sample* .Xdefaults *file with explanations of each line following as a comment.*

```
Mwm*interactivePlacement: false
! if true, you will have to position
! each window "by hand" with the mouse

Mwm*useIconBox: false
! takes up a lot less screen space

Mwm*keyboardFocusPolicy: pointer
Mwm*focusAutoRaise:      true
Mwm*autoRaiseDelay:      750

! These three lines let the mouse
! pointer automatically uncover
! and select the current window.
! If you prefer to specifically
! click on a window to select it,
! try these instead:

Mwm*keyboardFocusPolicy: explicit
Mwm*focusAutoRaise:      true
Mwm*startupKeyFocus:     true
```

long time, wait until you discover X and Motif!

It seems that the more visual the environment, the more personal it becomes. While it's annoying, perhaps, to do without your own private aliases on a strange machine, it becomes absolutely maddening to have a GUI that doesn't look, feel, and work the way you want it to.

The most obvious things that change your X environment (e.g., xsetroot, xset, and xterm) are explained clearly in the manual, and you can experiment with them on the fly. But others are initialized only on start-up, which means that experimenting with them can be time-consuming. I've found that the settings made by the .Xdefaults file shown in listing 2 can be useful.

Before you edit .Xdefaults, you can pick some nice default colors and fonts by looking in /usr/lib/X11/rgb.txt and running xlsfonts. David's Law of X states that on your first try, you are guaranteed to pick colors that aren't implemented on your hardware and fonts that you won't be happy with for more than a few minutes. Try again, and this time keep it simple.

More Tricks at Your Service

If you've been wondering how to get the X server running so that it initializes with the "floating logo" screen saver, try starting it up by putting a line like the following in a file called .xserverrc in your home directory:

```
/usr/bin/X11/Xsight -p 5 -save
300 -logo -v off
```

This works, as is the case on SCO Open Desktop, where the X server is Xsight from Locus Computing. Other servers can be called "X" rather than "Xsight." You can do this on the fly by executing the command xset s 300 5 s noblank.

There are some nonobvious things you can do with xterm. Try starting it up as xterm -T 'uname' -cr green in your .startxrc file. You'll not only be able to see the cursor, but the name of the machine xterm is running on will be clear. And you can use the same .startxrc file on any machine on your network with the correct results.

A marvelously straightforward introductory book on X is *The X Window System: A User's Guide* by Niall Mansfield

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Architecture Makes The Difference

HANDS ON/THE UNIX /bin

(Addison-Wesley, 1991, ISBN 0-201-56344-4).

Why X?

So now that all the little visual toys are set up nicely, can I do anything useful with them, or are they simply an excuse to buy more and faster computers? The answer, of course, is yes to both.

Because X was written on the client-server model, it can run on one or several computers simultaneously. The power of X becomes apparent when you run shells or applications on different networked machines, while the displays all go to windows on your single desktop monitor. And don't forget, since the source code for X is freely available, it has already been ported to almost every reasonable computing platform.

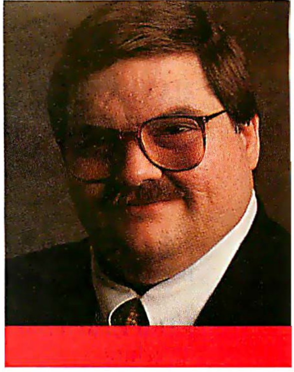
But wait, there's more. Motif (or any window manager) is simply an application program, and it can therefore run with X on a Unix machine. Suppose you obtain an X display server program for your networked PC and redirect the Unix-based X *and* Motif display to that PC. It will look just like you are running Motif on your PC. Thus, your PC can, with the right hardware and software, become an X terminal that will effectively "run" any program, graphical or otherwise, that you can run on your Unix machine.

This explains the popularity of X terminals themselves. In this current recessionary economy, not everyone can afford to purchase a computer workstation. I think many people are going to start turning their PCs into X terminals, at least part-time, because there's little extra investment required.

At the same time, X and Motif have some problems. High-level constructs available in the X toolkit and Motif library (`Xlib` and `Xm`) are indeed used to build X programs, but they are so complex that it can take pages of code to perform the simplest of functions. Executable files are not always portable, even across the same architecture. Still, X is the basis of every graphical application you're likely to see on Unix until the next century, and I'm happy it's around. ■

David Fiedler, a BYTE contributing editor, has been a consultant and writer on Unix topics for over a decade and has started several Unix publications. He's also the coauthor of the Hayden book UNIX System V Release 4 Administration. *You can reach him on BIX as "fiedler."*

Your questions and comments are always welcome. Write to: Editor, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458.



DON CRABB

MANAGING MAC UPGRADES

One reason for my being an unabashed Mac fan is the ease with which you can upgrade the machine. Adding hard drives is no tougher than plugging in another drive into the SCSI chain. And adding new video or other expansion capabilities is no tougher than plugging in an auto-configuring NuBus card and restarting the Mac.

That's the way it's gone for me since my first 128-KB Mac, back in January 1984 (except for the NuBus business, of course, which came with my first Mac II in 1987). I've plugged in disks, printers, modems, NuBus cards, and all manner of third-party doodads without so much as a whimper, much less a groan, from my Macs. Until now. Last night saw a struggle before I finally succeeded in replacing my trusty old SuperMac Technology Spectrum/8 video card (8 bits of color on a SuperMac 19-inch Trinitron RGB monitor) with a hot new SuperMac Thunder/24 card.

The Thunder/24 card (aptly named) is one of a new generation of ultrafast 32-Bit QuickDraw accelerator video cards. It provides 24-bit video (16.7 million colors), where my old Spectrum/8 card could handle only 256 shades.

The Thunder/24 can accelerate both 8- and 24-bit modes on the Mac. The Thunder/24 that I installed in my Mac IIci (a machine that I have already accelerated with a DayStar Digital 50-MHz 60830 PowerCache card and a DayStar 64-MB RAM PowerCard) included the maximum 8 MB of extra GWorld video RAM. This helps accelerate off-screen bit maps that some video and animation software packages use.

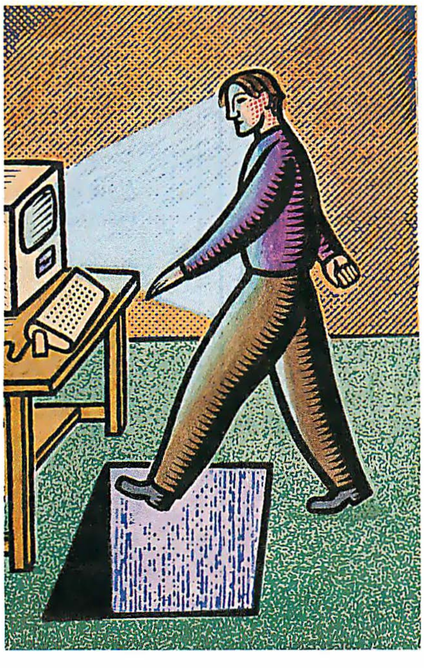
In the informal tests that I conducted, the Thunder/24 was three to 30 times faster in 8-bit acceleration mode than my old Spectrum/8, depending on the software. It made working with 24-bit mode a pleasure, instead of the jerky updating that caused me to remove my older Spectrum/24 in the first place (and go back to the Spectrum/8).

Installation Difficulties

The Thunder/24 has explicit installation instructions. Being an experienced and somewhat arrogant MacFolk, I quickly dispensed with these in favor of the Crabb Standard Method—plug the sucker in and get going. That was a mistake.

I had forgotten an important piece of NuBus auto-configuration lore: When you remove an existing card (in this case, the Spectrum/8), you need to restart the Mac with no card in that slot to clear the old NuBus card settings from PRAM. Normally, the Mac checks the card IDs with copies of IDs stored in PRAM. If they don't match, it auto-configures the new card into the system. Occasionally, for reasons unknown, this mechanism fumbles. Hence the lore.

A firsthand account of the trials and tribulations of upgrading Macs



You risk doing exactly what I did—installing the new card in the old slot, restarting the machine, and watching the auto-configuration software misstep. As far as the Mac is concerned, nothing at all has changed, so it uses the old NuBus PRAM settings for that slot. In the case of the Thunder/24, those settings aren't compatible with the old Spectrum/8 settings. As a result of this bit of upgrade hubris on my part, I not only succeeded in disabling my 19-inch display (I couldn't even get the display to recognize the Thunder/24's self-test mode), I also blew away an Integrated Data Storage Systems' Wip40Q SCSI hard drive that was sitting at the end of my SCSI chain.

Fortunately, I had a second display connected to my IIci (an AppleColor 13-inch RGB monitor connected to an Apple 8•24GC accelerated NuBus card), so I wasn't flying totally blind. After removing the Thunder/24, restarting the machine to clear out that slot's PRAM, and replacing the card (all the while checking the configuration using the working Apple monitor), I finally got the thing into self-test mode.

Satisfied that I had fried neither the card nor the monitor, I put the Thunder/24 into its monitor setup mode, where it would march through different monitor synchronization rates until it found the right one for my monitor. When the card hit the correct monitor frequency, I would see an image of a keyboard, at which point I would bang the space bar to lock in the scan frequency.

Unfortunately, in all my fiddling, I had managed to loosen the Apple Desktop Bus (ADB) connection to my keyboard. Thus, the blasted thing wasn't transmitting my space-bar signal, and the board kept cycling through its test patterns. Most annoying. Finally, my brain came back on-line, and I reconnected the keyboard and

ILLUSTRATION: TIM GRAJEK © 1992

signaled the right pattern. Things have been fine ever since.

I Did Learn Something

This little experience taught me a few important lessons. First, no matter how experienced you are at adding NuBus cards to your Mac, you must read and follow the directions from the card's manufacturer. Second, try to eliminate all other interactions (e.g., loose ADB cables) when upgrading your Mac. You might mistakenly assume that you're having problems with the upgrade when the real problems are those you created yourself beforehand.

Finally, *never* think that upgrading your Mac is a simple task. It might be easy, especially when you follow directions, but the stuff that is going on behind the scenes of a "simple" NuBus card insertion is anything but simple.

Software of the Month

One of the problems I faced when I completed my Thunder/24 installation was the dead Wip40Q drive. This baby was sitting at the end of my SCSI chain, and it didn't like all the fiddling I had done. It simply refused to put in an appearance on my

Never think that upgrading your Mac is a simple task.

Desktop. I tried the old public domain standbys SCSIProbe and SCSITools (two Control Panels) to get the Wip40Q back on-line, but neither could do the trick. Both Control Panels showed the drive hooked to the SCSI chain and its SCSI ID number, but neither was able to mount it.

Because I had two fresh and complete backups of this drive (courtesy of Dantz Development's outstanding Retrospect backup program), I wasn't too worried about blowing away the data on this drive. I just wanted to get the thing back on-line where it belonged. I also wasn't too sanguine about using the formatting utility that came with the Wip40Q to assist in this function, because I had had trouble with it in the past.

As I was contemplating a backdoor solution to my problem (I thought about hooking the Wip40Q to another Mac and accessing it as a file-share drive), I went through the day's mail. One of the things I found was a utility called DiskMaker 1.10 from a company I had never heard of: Golden Triangle Computers. This utility had been sent to me so that I could format the Quadram QuadFlextra drive I had been sent to play with (this is one of those new drives that squeezes 20 MB onto a special floppy disk; I'll have more to say about it next month, but so far it's worked beautifully).

After I read the DiskMaker manual, it was pretty clear to me that it was far more than a specialty utility for the QuadFlextra. It was a full-blown SCSI drive formatter and manager. Since I've always been a fan of such utilities—LaCie's Silverlining has been at the top of my list and was waiting in the wings if DiskMaker failed—I decided to give DiskMaker a chance.

I fired up DiskMaker, and it found the Wip40Q without failure. In fact, merely clicking on its icon in the DiskMaker

control window made it magically appear on the Desktop (the manual doesn't mention this capability). That gave me a chance to check the disk out with Symantec Utilities for Macintosh II, the System 7.0–compatible version of SUM. SUM II revealed that the directory was scrambled. I ran the SUM Recovery program, pulled off all the files and stuck them on another disk, wiped the disk clean, and proceeded to reformat it with DiskMaker.

DiskMaker formatted the disk in short order, and I used it to install a "polled" SCSI driver on the disk. A polled driver handles the transfer of data by requesting and acknowledging the transfer of each byte that the Mac file system sends it. This kind of driver is a bit slower than a blind driver (which compiles a series of transfer requests before reading or writing them blindly), but it is the most reliable. DiskMaker can also write a blind SCSI driver, but my experience with the Wip40Q showed it to be a bad candidate for that type of operation.

After all this fiddling, the Wip40Q is now back on-line, humming along nicely with the other drives, and working with the SuperMac Thunder/24 card without a hitch. The DiskMaker driver has proven so reliable that I'm thinking of eventually reformatting my other SCSI drives with it so I can install this driver. ■

Don Crabb is the director of laboratories and a senior lecturer for the computer science department at the University of Chicago. Don is also a contributing editor for BYTE. His new book on System 7.0 is now in bookstores. He can be reached on BIX as "decrabb."

Your questions and comments are welcome. Write to: Editor, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458.

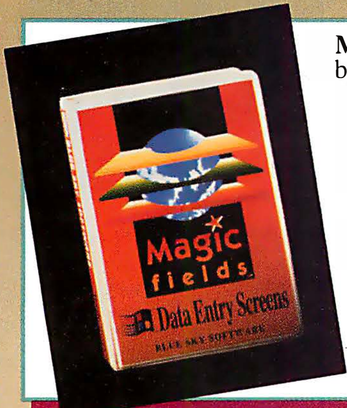
ITEMS DISCUSSED

DiskMaker 1.10 ....$79
Golden Triangle Computers, Inc.
(619) 279-2100
Circle 1146 on Inquiry Card.

Symantec Utilities for Macintosh II $149.95
Symantec Corp.
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Thunder/24 ....$4999
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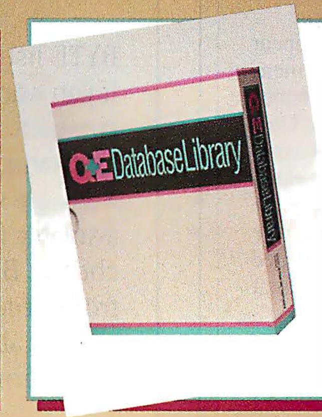


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File Pro Plus	699	669
Magic PC	800	779
Paradox V3.5	795	555
R:BASE 3.1	795	645

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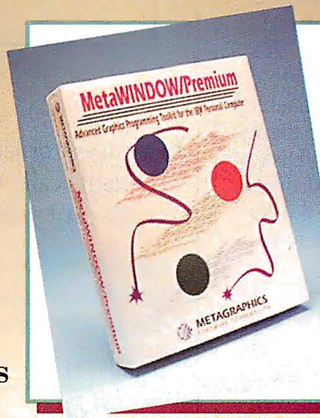
DataBoss	695	649
Genifer	395	289
Pro-C w/Workbench	795	735
UI2 Developer's Release	595	449

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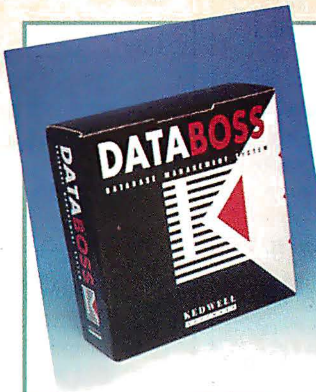


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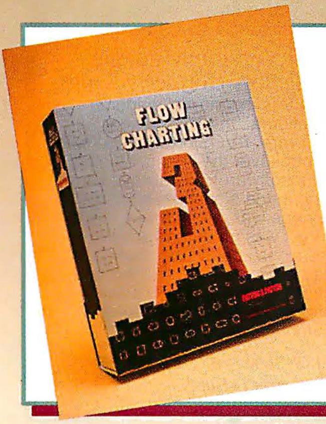
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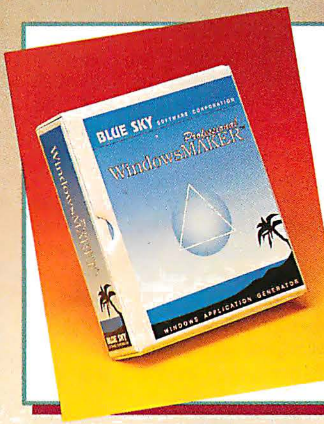
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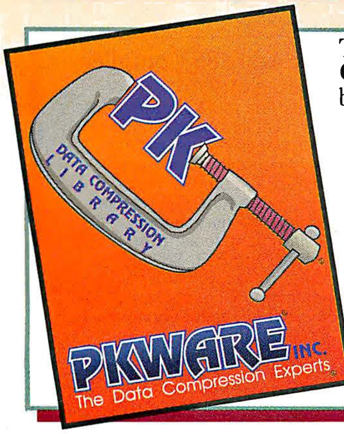
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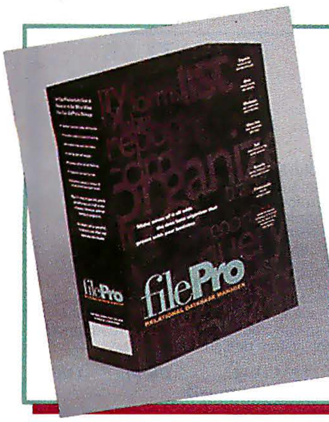


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The PKWARE Data Compression Library allows software developers to add data compression technology to applications. The application program controls all data I/O, allowing data to be compressed or extracted to any device or area of memory. Only 35K of memory is needed to compress data, and only 12K is needed to extract data.

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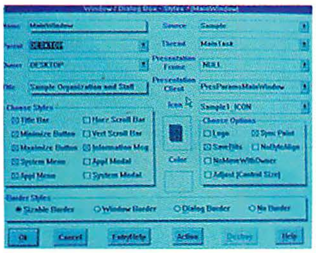
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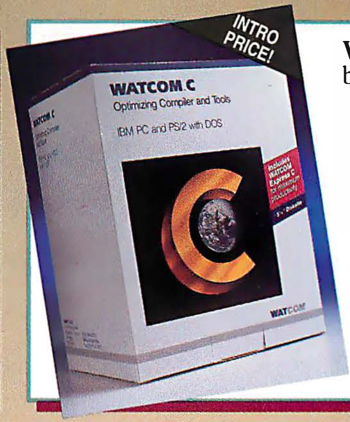


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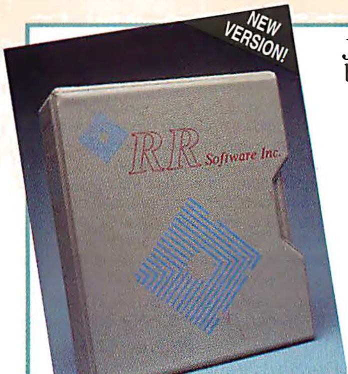
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by Intersolv (formerly Sage)



PVCS is the market leader in Configuration Management software. PVCS provides complete control over the configuration of your software. You always know who made a change, what the change was, when it was made, why it was made and what revisions contain the change. You can even prevent unauthorized changes and coordinate revisions, special versions and upgrades – automatically.

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FastFaxts 111-089

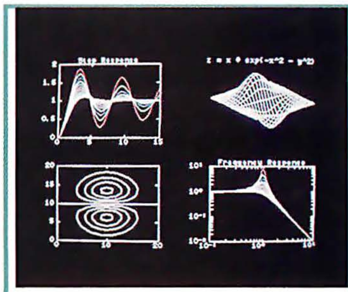
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ASK BYTE

Coprocessor Crunch

I am considering buying a math coprocessor for my 20-MHz 386SX and noticed several ads in BYTE. One claimed that the Cyrix chip was faster than the Intel chip. Is there really a difference in the various math coprocessors from Intel, Cyrix, and Integrated Information Technology (IIT)?

John Graham
Lake Mary, FL

All the FPUs, except for the Weitek Abacus 3167 and 4167 chips, are functional equivalents of their Intel counterparts. However, differences in the internal design of each chip let some FPUs perform some operations faster or use less power. BYTE Lab technical director Rick Grehan reviewed and benchmarked FPUs in "FPU Face-Off" in the November 1990 BYTE. Unfortunately, no 387SX clone chips were available at that time. Of the chips tested, he liked IIT's 2C87 for 286 machines and Cyrix's FasMath 83D87 for 386DX-class machines. Weitek's Abacus chips also performed well, but they are not 387-compatible. Thus, your application has to support them.—Stan Wszola

Move Over, Mac

I have just moved to a new job where I'm the only PC user in a veritable sea of Macs. Everyone here is on an AppleTalk network. I'm completely shut out from accessing the laser printer, interoffice communications, and any direct link to mainframe services. I've heard that I can buy a card and some software for my PC that will let me connect to the Mac network. Could you please help me out with PC-to-Mac communications and the names of network cards?

Charles Ramcharan
Sackville, New Brunswick, Canada

Of all the multiplatform networking schemes available for desktop machines, AppleTalk is one of the few that has its act together. Because it's so well defined, many vendors offer AppleTalk products.

First, get your PC cabled to the network. AppleTalk can run over Ethernet, token ring, LocalTalk, or twisted-pair wiring (e.g., Farallon Computing's PhoneNet). I'll assume that you're using LocalTalk or PhoneNet.

*To connect to your AppleShare server, you can use one of two products. The PhoneNet Card PC*LocalTalk is available for $295 from Farallon Computing (2000 Powell St., Emeryville, CA 94608, (415) 596-9000). The DL series interface is available for $299 from Dayna Communications (50 South Main St., Fifth Floor, Salt Lake City, UT 84144, (801) 531-0600). The Farallon package comes with a PhoneNet cable connector and AppleShare file/print access software. Dayna's DL card comes with DaynaShare (equivalent to Farallon's access software) and a DB-9 connector that accepts a standard LocalTalk or PhoneNet connector.*

This may sound like alphabet soup, but it's straightforward. You simply drop the card into the PC, connect the interface node to the board and the network, and install the software. If your Macs use NetWare for Macintosh, you'll want the Dayna product, which includes NetWare support. The Farallon software simply makes the PC look like another Mac on the AppleTalk network.

That takes care of printing and file sharing. For communications, two popular E-mail packages allow sending Mac mail to and from PCs. QuickMail (CE Software, Inc., P.O. Box 65580, 1801 Industrial Cir., West Des Moines, IA 50265, (800) 523-7638) and Microsoft Mail (Microsoft Corp., 1 Microsoft Way, Redmond, WA 98052, (800) 426-9400) are both adept at talking bilingually. I'm not sure how your mainframe link works, but if you're using either NetModem or NetSerial (Shiva Corp., 1 Cambridge Center, Cambridge, MA 02142, (800) 458-3550), the DOS Connect program will let you tap in from the PC.—Howard Eglowstein

Environment Space

Steve Apiki's response to Paul M. Smith's question about environment space and Windows 3.0 (Ask BYTE, October 1991) is appropriate in the standard DOS situation, but it does not seem to work with a .BAT file invoked under Windows.

My experience (which included increasing the environment size in the CONFIG.SYS file, as suggested) showed that when Windows spawns a DOS window, it sets the environment size to be only as big as currently required. There is no space available for other variables.

I solved the problem by creating a lengthy entry in the environment prior to calling Windows. For example, I type `SET ENVIRONMENT_FILLER=abcdefghij...` and then run Windows. Next, I clear the environment space at the beginning of every .BAT file by typing the following:

```
@ECHO OFF
SET ENVIRONMENT_FILLER=
```

This yields many spare characters for use as variables within the .BAT file. The number depends on how many characters you insert in the original `SET` statement.

I have read through the descriptions of the various Windows .INI files to see if there is a way of extending the environment, but I haven't found it yet.

I trust this helps.

Rick Lugg
Bryanston, South Africa

Laser-Printer Engine Orphans

Some time ago, several raw Canon LBP-CX laser-printer engines came into my possession. They are old but faithful and almost unused. It would be a shame to throw them away. However, they are without a standard interface. The only outside connection is the video/control interface. If I could get more out of them

than current base models, some investment could be warranted.

In the text box "New Life from an Old Printer" (October 1991 BYTE, page 204), you mention ways to revitalize old engines. Unfortunately, the company addresses are not listed.

Torbjorn Sund
Tromso, Norway

We inadvertently left out the addresses. Here they are:

Canon U.S.A., Inc.
1 Canon Plaza
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Questar Technologies, Inc.
500 Alden Rd., Suite 212A
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Canada L3R 5H5
(416) 477-1918

Skeller Associates
1336-A Channing Way
Berkeley, CA 94702
(415) 649-4831

You might want to contact Questar's German office at Botzinger Strasse 60, 7800 Freiburg, Germany, 049-761-47804-13.—Raymond G A Côté

Unix Communications

I am looking for a copy of uucp for communicating from some remote DOS machines to our Unix system. Can you help me?

Jim Handsel
Honolulu, HI

You can find versions of uucp *(the Unix-to-Unix copy program) to suit every budget and adventurous spirit. In the public domain, look for a version of* uucp *for DOS and OS/2 on BIX (join the ibm.os2/listings conference and download uupc11k2.zip). Austin Code Works (11100 Leafwood Lane, Austin, TX 78750, (512) 258-0785) sells a copy of* uupc *for $25. Both versions include source code; neither is a commercial package.*

If you prefer a commercial package, try Software Concepts Design (594 Third Ave., New York, NY 10016, (212) 889-6431). Its RamNet program, which sells for $149, provides concurrent background processing of data transfers. Vortex Technology (P.O. Box 1323, Topanga, CA 90290, (310) 455-9300) publishes UULINK, which also supports unattended data transfers.

—Raymond G A Côté

Video Info

I would like some information about the Tseng Laboratories ET 4000 VGA controller chip, especially hardware-related information. I read about the Tseng Labs data book. How can I find it?

I would also like information about the programming of Edsun's Continuous Edge Graphics D/A converter chip. I want to write programs in C, BASIC, and assembly language using the CEG mode.

Gyorgy Komarik
Baltimore, MD

You can get a data book and other references for the Tseng Labs chip by writing to Tseng Laboratories, Inc., 10 Pheasant Run, Newtown Commons, Newtown, PA 18940, (215) 968-0502.

The Edsun chip is an exciting new development that won a BYTE Award of Distinction (see "The 1990 BYTE Awards," January 1991). Edsun claims that the chip brings photo-realistic graphics to standard VGA displays by smoothing the rough edges of graphics images. A big problem right now is the lack of driver software for PC applications, so Edsun should welcome new developers. You can contact the company at Edsun Laboratories, Inc., 564 Main St., Waltham, MA 02154, (617) 647-9300.

—Stanford Diehl

IDE Worries

I have an IDE hard drive system, but I am not sure what I can and cannot do with it. I am scared of buying software that doubles disk capacity, unfragments disks, password-protects disks, and the like. The manuals for some popular packages (e.g., PC Tools) mention only the standard interfaces, not IDE. Is there any reason for me not to purchase any of these products, like Norton Utilities, as long as I don't do low-level formatting?

Chris Murphy
Denver, CO

You've hit the head right on the platter. Most disk utility packages will support IDE drives and can perform every operation except low-level formatting. I recommend calling the manufacturer of the software you plan to purchase to make sure it supports IDE drives.

The embedded controller in an IDE drive masks the actual physical characteristics of the hard disk so that it can maintain compatibility with current DOS BIOSes. This scheme lets the drive work properly with DOS and provides other benefits (e.g., letting the hard disk have more than the DOS limit of 1024 tracks). Regardless of the drive's actual physical characteristics, the software sees a standard geography. That's why disk utilities cannot low-level format the disk: They can't know the actual physical characteristics of an IDE drive.

You need not worry about an accidental low-level format. The drives receive their low-level format at the factory, and an IDE drive won't accept a low-level format command. Other operations (e.g., disk caching, pattern testing, data recovery, data relocation, password protection, and data compression) will work as expected on an IDE drive.—Stanford Diehl ■

The BYTE Lab welcomes your questions. Address correspondence to Ask BYTE, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458. You can also send BIX mail c/o "editors."

We read every letter, but due to the volume of mail received, we cannot guarantee a response. We edit all letters for clarity and brevity. Letters appear in BYTE about four months after we receive them.

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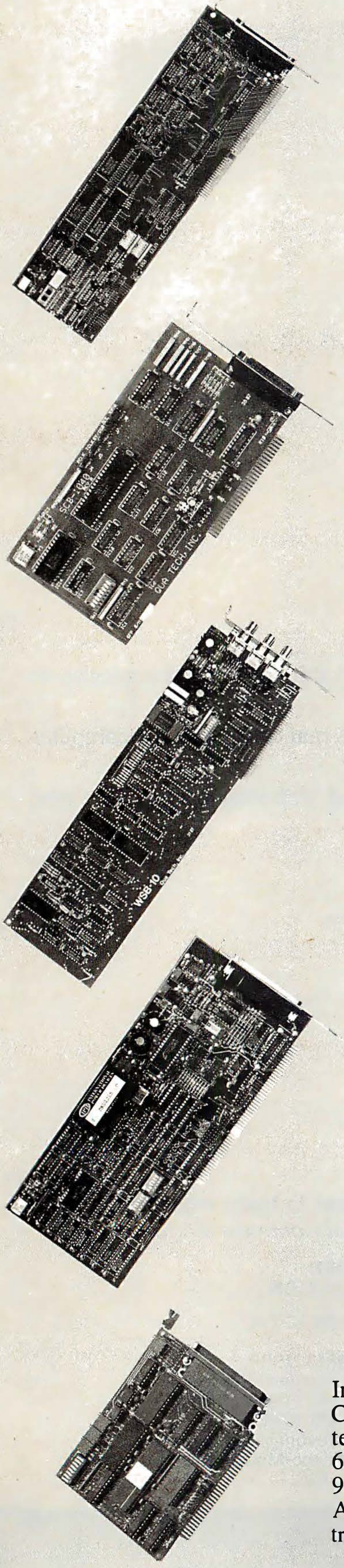
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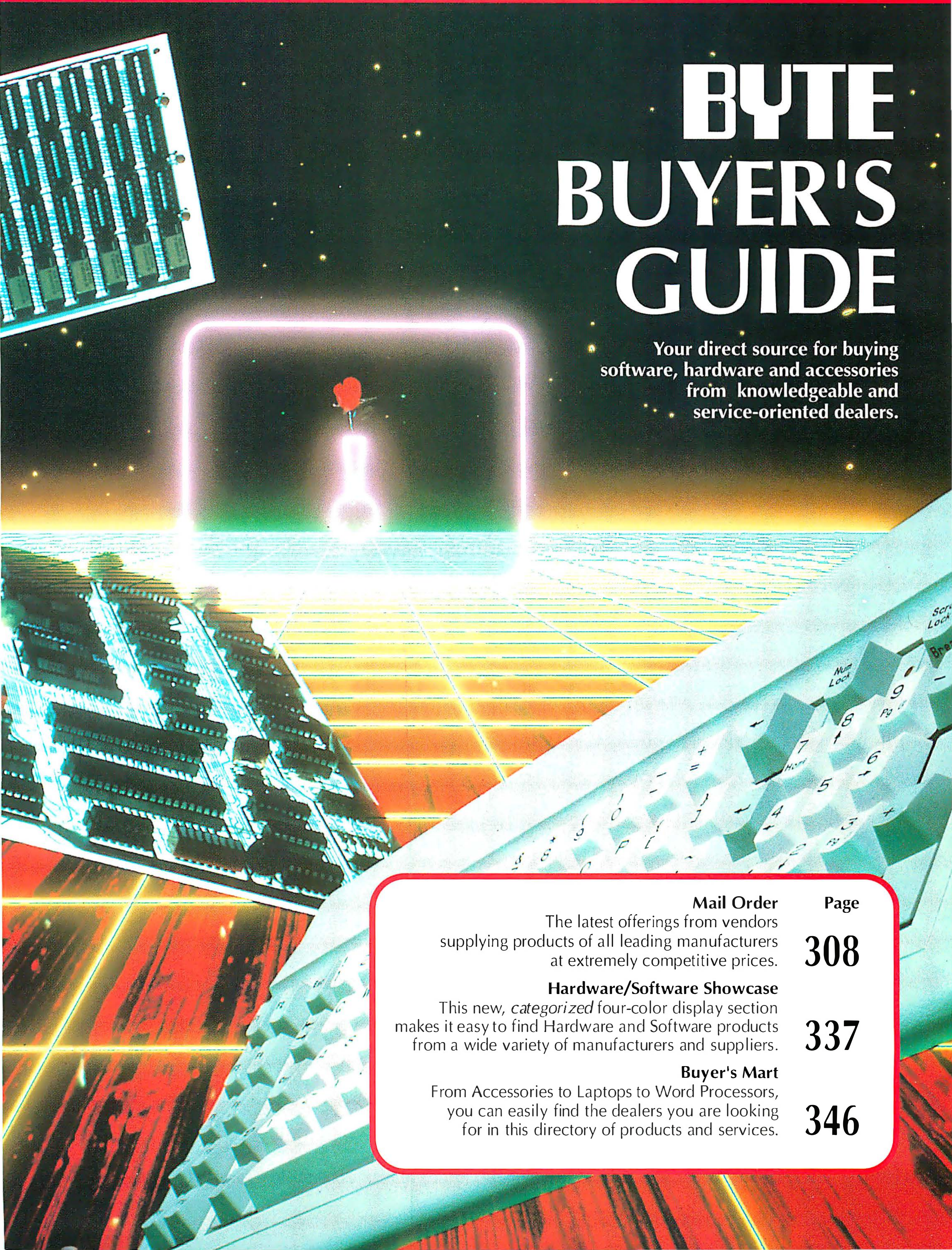
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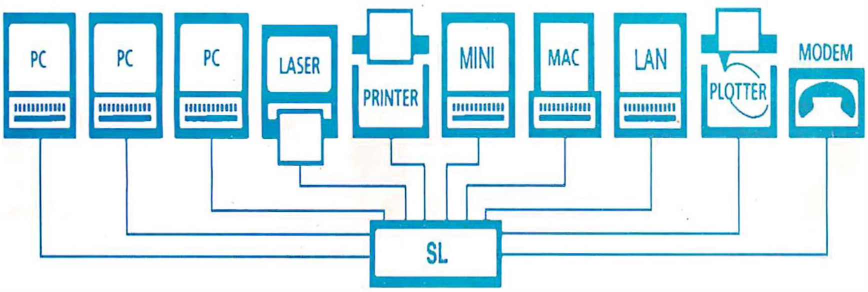
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MODEL	MEMORY ADDED	COMPAQ EQUIV. PART#	YOUR COST
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III	INTFC BD	107808-001	**149.00**
	EXPBD	107811-001	**199.99**
	2MB KIT	107332-001	**119.00**
SLT/286	1MB MODULE	110235-001	**129.00**
	4MB MODULE	110237-001	**458.00**
LTE/386S/20	1MB	121125-001	**169.00**
	4MB	121125-002	**419.00**
LTE/286	1MB BOARD	117081-001	**89.00**
	4MB BOARD	117081-003	**398.00**
PORTABLE	1MB KIT	107651-001	**169.00**
386/20	INTFCBD	107707-001	**88.00**
	4MB BOARD	107653-001	**479.00**
	4MB EXTBRD	107654-001	**479.00**
SLT/386	1MB MODULE	118303-001	**129.00**
	2MB MODULE	118304-001	**219.00**
	4MB MODULE	118305-001	**469.00**

TOSHIBA MEMORY

TOSHIBA MODEL	MEMORY ADDED	TOSHIBA EQUIV. PART #	YOUR COST
PORTABLE 2000SX	1MBBD	PC14-PA8311U	**129.00**
T1000SE & XE/LE	2MB BD	PC14-PA8312U	**179.00**
T2000/T2000SX	1MEG	PC18-PA8316U	**119.00**
	2MEG	PC18-PA8317U	**179.00**
T2000SX/T1000LE	4MEG	PC-PA8314U	**399.00**
	8MEG	PC14-PA8315U	**679.00**
T2000SXE/2200SX	2MEG	PC-PA2000U	**189.00**
	4MEG	PC-PA2001U	**419.00**
	8MEG	PC-PA2002U	**719.00**
T3100E	2MEG	PC9-PA8340U	**119.00**
PORTABLE T1200XE	2MB BD	PC13-PA8306U	**119.00**
PORTABLE T1600	2MB BD	PC8-PA8302U	**119.00**
PORTABLE T3100E	2MB KIT	1PC9-PA8341U	**148.00**
PORTABLE T3100SX	2MB BD	PC15-PA8308U	**119.00**
	4MBBD	PC15-PA8310U	**229.00**
PORTABLE T3200	3MBBD	PC6-PA7137U	**219.00**
PORTABLE T3200SX &	2MB KIT	PC12-PA8307U	**119.00**
T3200SXC	2MB	PC19-PA8318U	**129.00**
	4MB KIT	PC12-PA8309U	**229.00**
	4MB	PC19-PA8319U	**289.00**
PORTABLE T5100	2MB BD	PC7-PA8301U	**119.00**
DESKTOP T8500 or	2MB KIT	PC10-PA8304U	**119.00**
PORTABLE T5200 & T5200C	8MB KIT	PC10-PA8313U	**638.00**

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8088 XT MACHINES - BOCARAM 8 Bit 0-2 MEG BOARD. USES 256K D-RAM. OK **99.00** 1 Meg **148.00** 2MEG **189.00**

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DESCRIPTION	150NS	120NS	100NS	80NS	70NS
64X1	**1.20**	**1.45**	**1.65**		
64X4	**1.95**	**2.25**	**2.45**	**2.95**	
256X1	**.95**	**1.05**	**1.10**	**1.15**	**1.95**
256X4		**3.95**	**4.45**	**4.95**	**5.45**
1MEG X1		**3.50**	**3.85**	**4.10**	**4.45**

IBM PS/2 MEMORY

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IBM PS/2 MODEL	MEMORY ADDED	IBM EQUIV. PART#	YOUR COST
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PS/225/286	512K KIT	30F5348	**38.00**
30-286, 50Z & 55-SX,65SX	2MB KIT	30F5360	**107.00**
PS/250Z&55SX,65SX	1MBSIMM	6450603	**59.00**
	2MBSIMM	6450604	**89.00**
55SX&65SX	4MBMODULE	34F2933/87F9977	**219.00**
50, 50Z, 55SX &60, 65SX	2-8MB BOARD	1497259/6450609	**349.00**
PS/2	1MBSIMM	6450603	**52.00**
70-E61,061,121,P70	2MBSIMM	6450604	**89.00**
PS/270-A21 A61,B21,B61	2MBSIMM	6450608	**98.00**
PS/280-041	1MB MODULE	6450375	**98.00**
PS/280-111,121,311,321	2MB MODULE	6450379	**138.00**
80-A21, A31, A61	4MBMODULE	6451060	**249.00**
PS/235SX LS&40SX	8MB	6450129	**499.00**
PS/2	2-8MBBOARD	6450605OR	**328.00**
ALL70s&80s	2-14MB BOARD	34F3077OR	**358.00**
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HPII&IID	2MB MODULE	33444B	**107.00**
	4MBMODULE	33445B	**177.00**
HP3&IIID	1MBMODULE	33474A/B	**98.00**
HPIIP	2MBMODULE	33475A/B	**117.00**
	4MBMODULE	N/A	**187.00**
HPIIISI	1MBMODULE	N/A	**79.00**
	4MBMODULE	N/A	**229.00**

SIMM MODULES

DESCRIPTION	120NS	100NS	80NS	70NS	60NS
256X8	**5.00**	**8.00**			
256X9	**9.00**	**14.00**	**17.00**	**26.00**	**29.00**
1MEG X 9		**39.00**	**42.00**	**49.00**	**64.00**
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• Keyboard, 101 Keys	• Keyboard, 101 Keys	• Keyboard, 101 Keys	• SVGA Card	• SVGA Card
• SVGA Card	• SVGA Card	• SVGA Card	• 1024 x 768 Monitor, 28 dp	• 1024 x 768 Monitor, 28 dp
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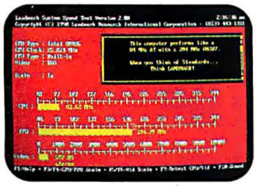
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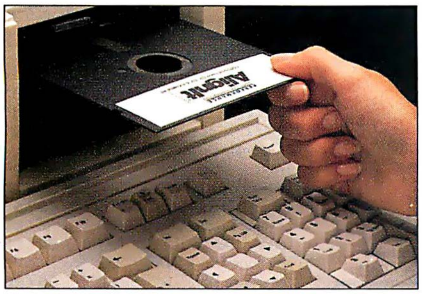
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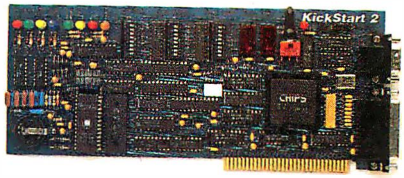
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> ***"KickStart 2 system diagnostics board helps users check out virtually every aspect of a PC's hardware system... the board is a worthy investment for computer maintenance." David Claiborne, PC Week***



KickStart 2 is ideal for permanent installation. It eliminates the need for an I/O card, provides remote and on-site diagnostic capabilities for quick repair time and offers a solid hardware based solution to unauthorized access with impenetrable password protection.

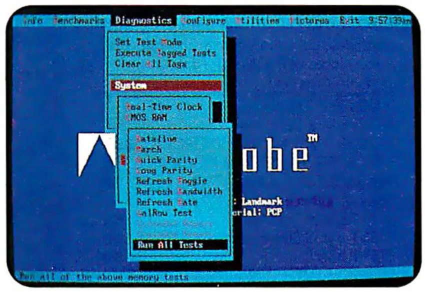
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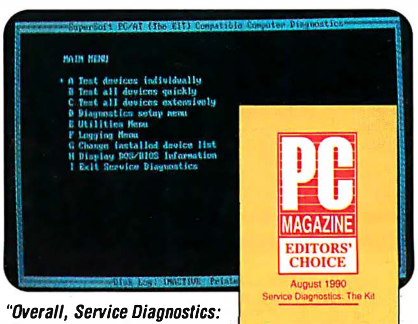
The 200 page on-line manual has built-in table of contents, *topic/text search*, and troubleshooting tips. PC Probe comes with dual size floppies and 9 & 25 pin serial/parallel port loopback plugs. For PC XT, AT, 386, 486 and compatibles using DOS 2.0 or higher. ***CALL for current pricing!***

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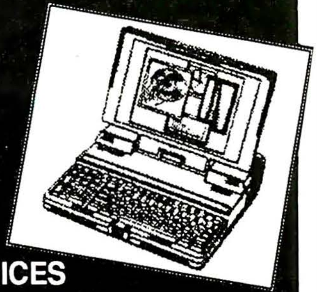
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EXTERNAL 40MB BATTERY-POWERED HD UPGRADE	$498
EXTERNAL 60MB BATTERY-POWERED HD UPGRADE	$578
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T3200SX	120MB *WITH 13MB RAM*	$CALL
T3200SX	40MB *WITH 13MB RAM*	$CALL
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T2000SXE	60MB *WITH 10MB RAM*	$2,998
T2000SXE	40MB *WITH 10MB RAM*	$2,758
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T1600	20MB *WITH 5MB RAM*	$1,338
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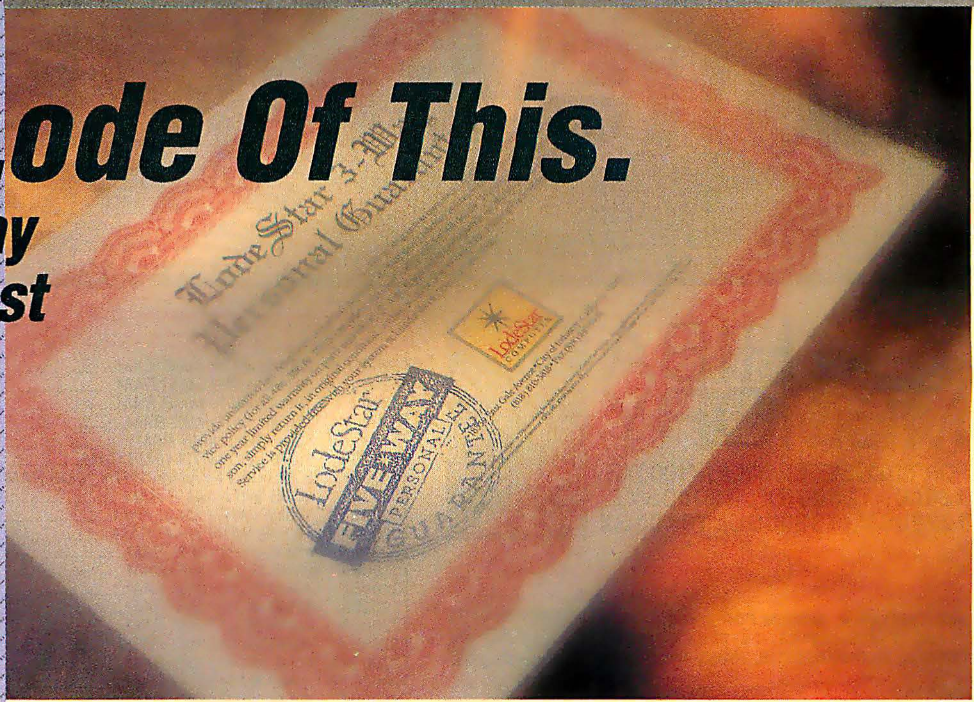
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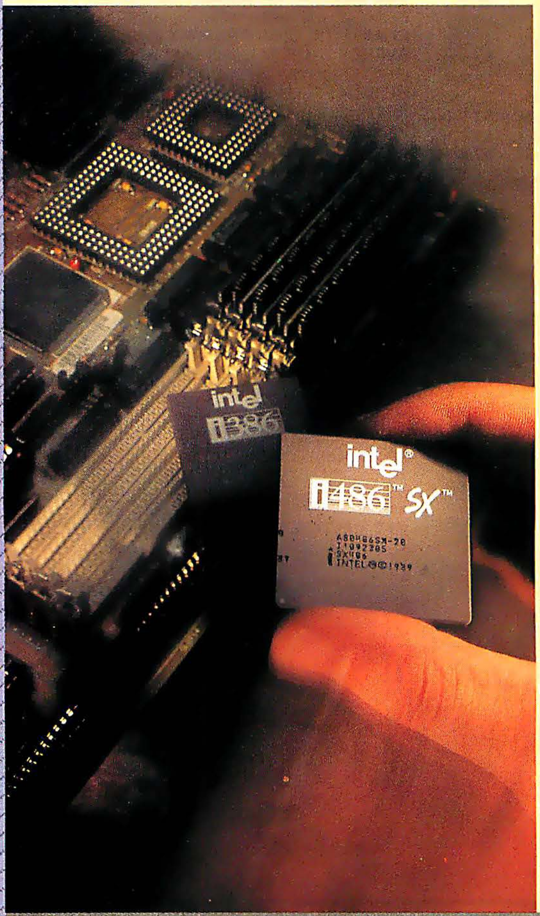
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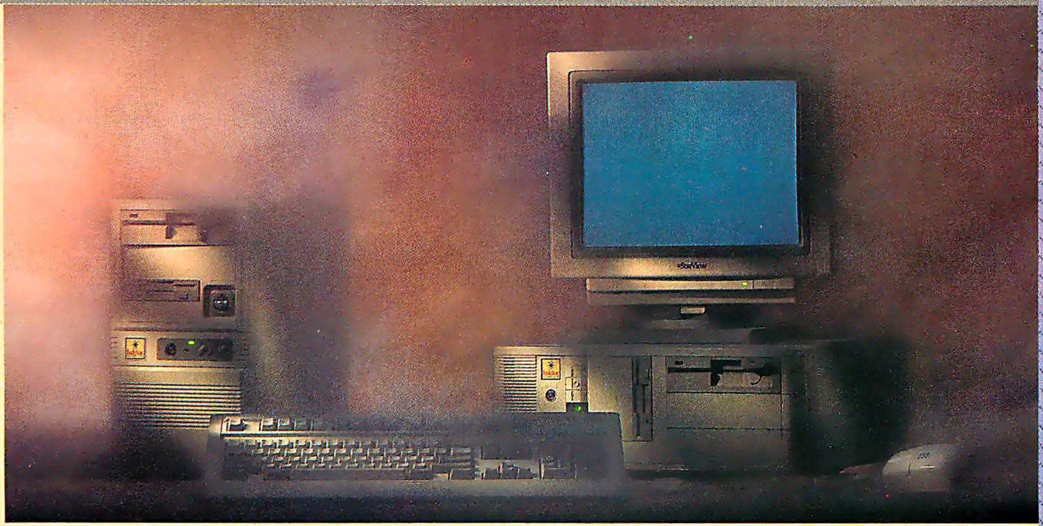
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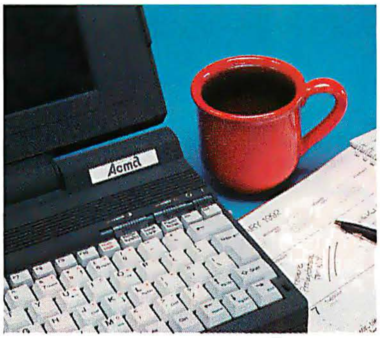
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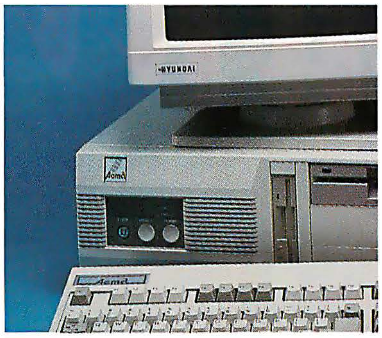
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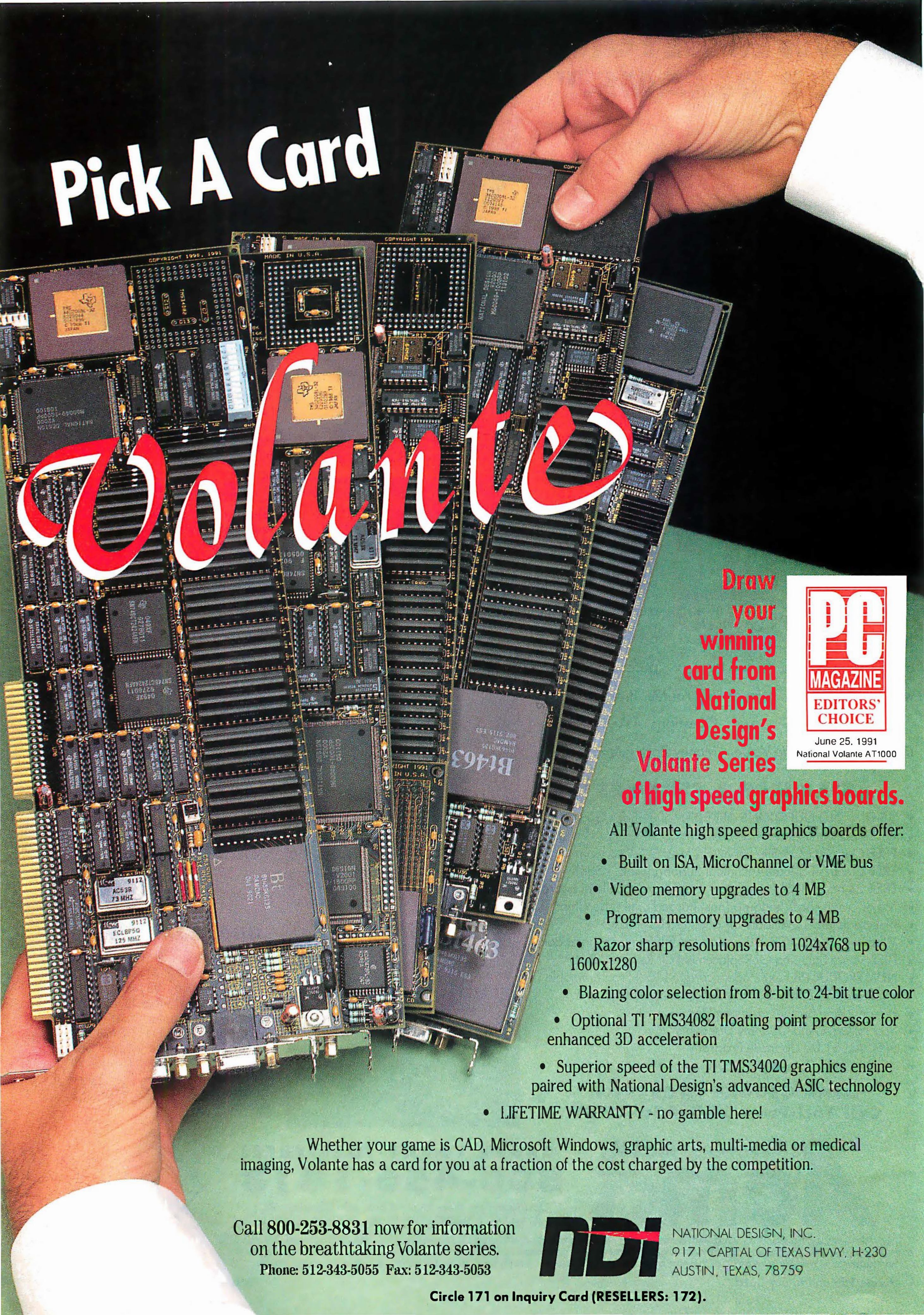
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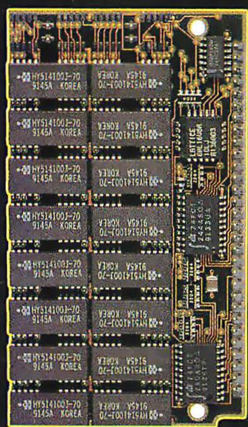
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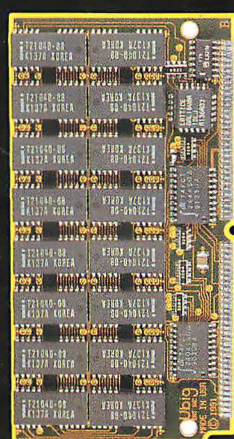
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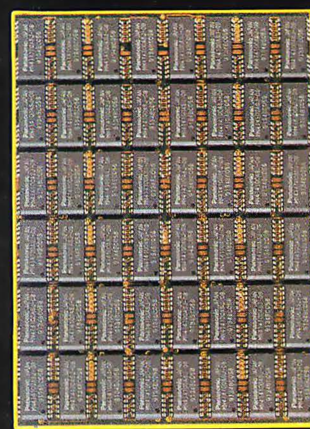




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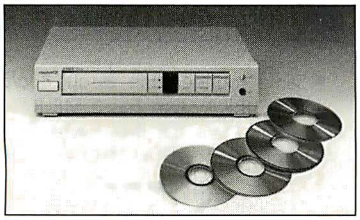
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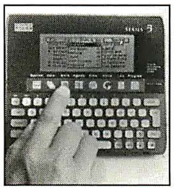
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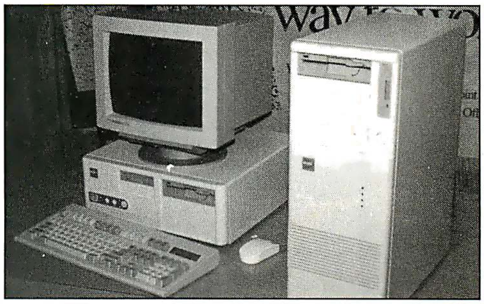
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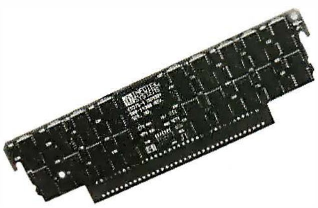
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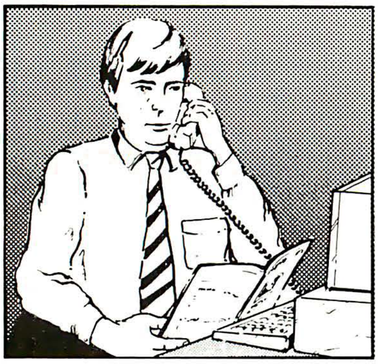
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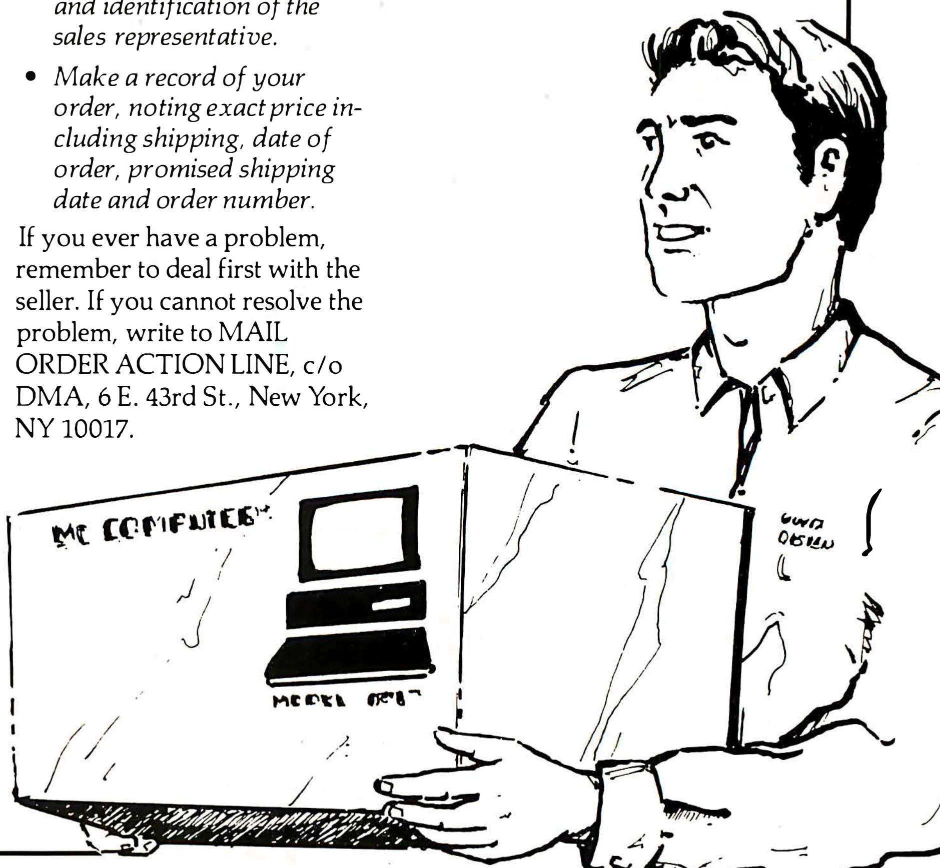
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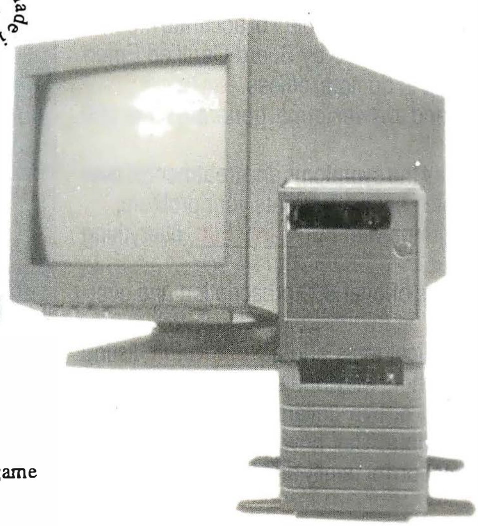
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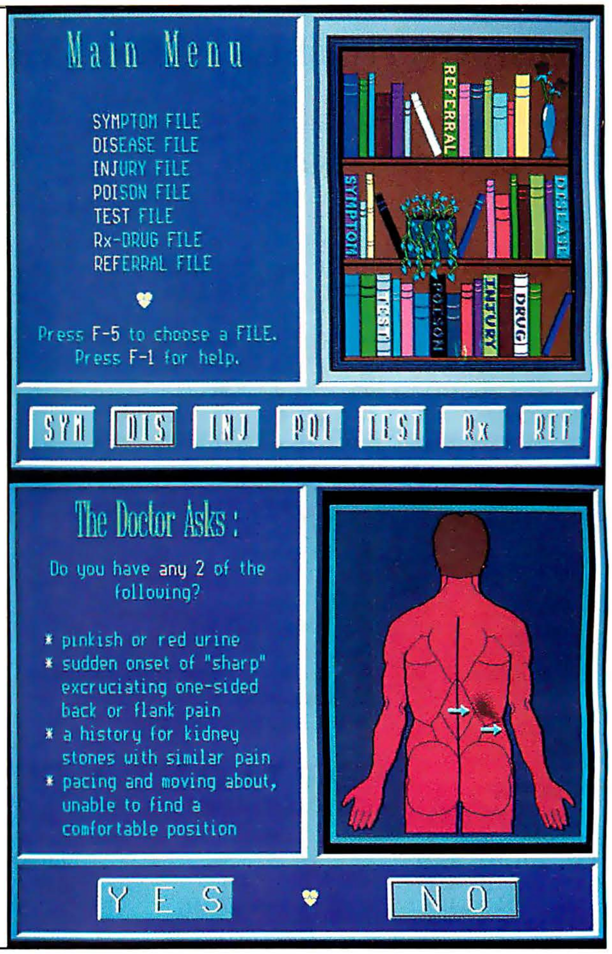
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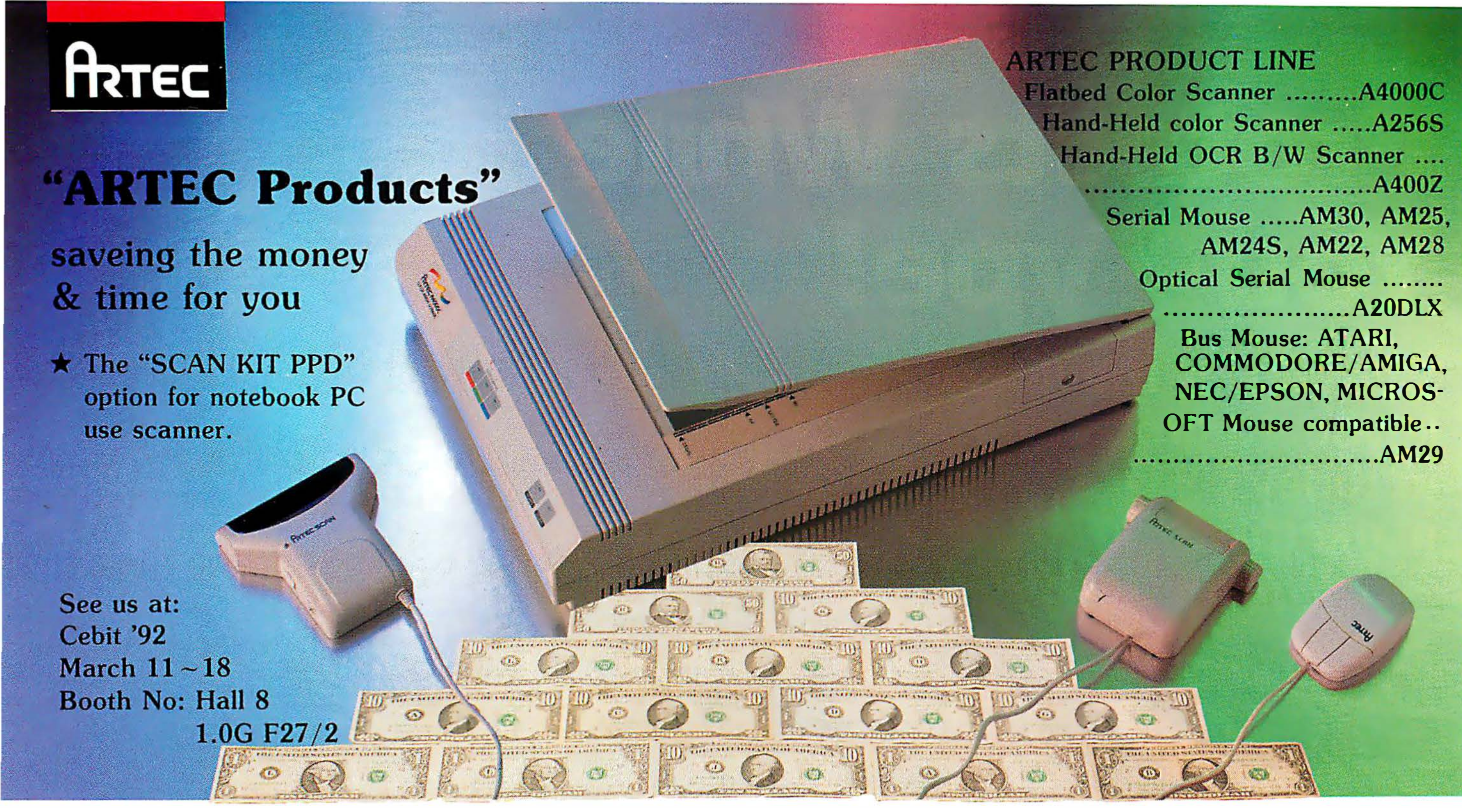
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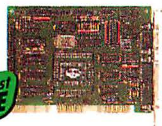
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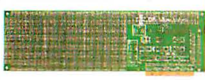
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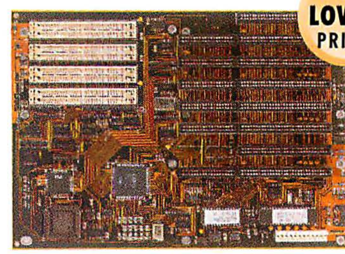
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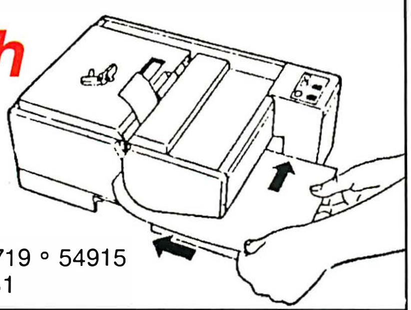
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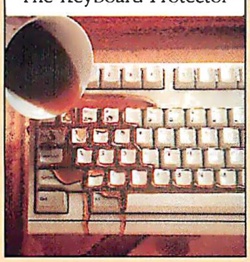
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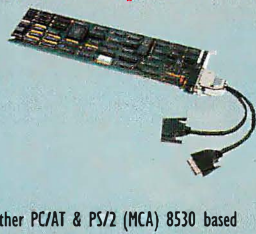
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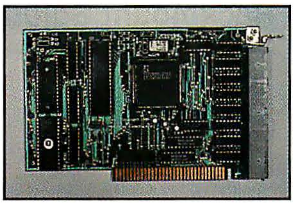
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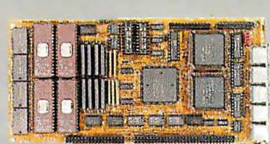
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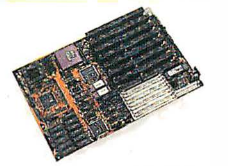
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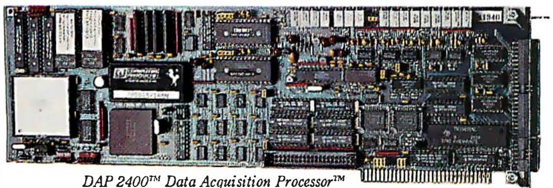
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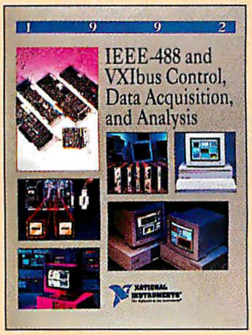
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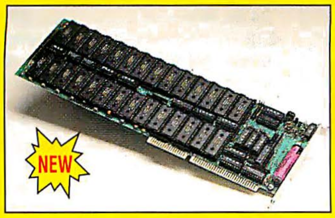
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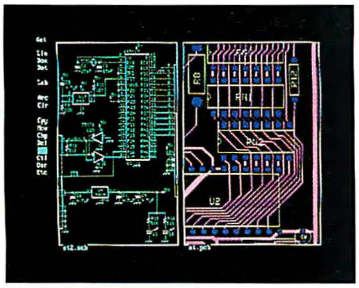
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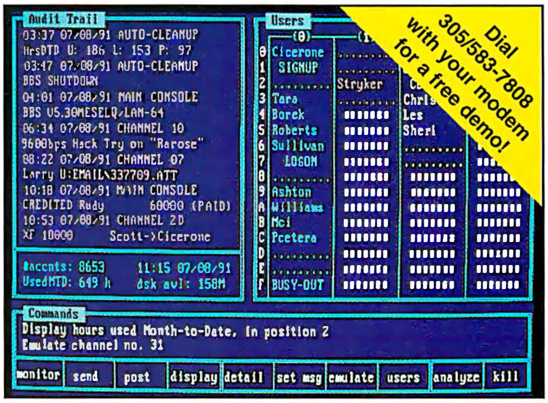
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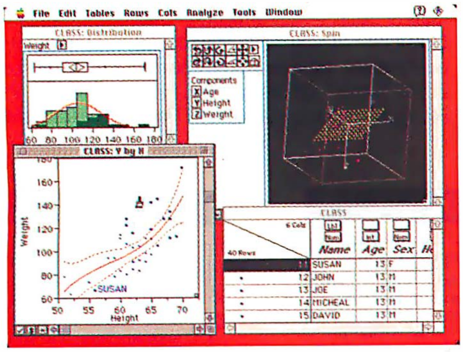
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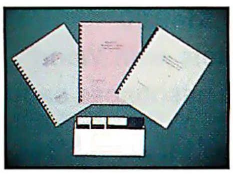
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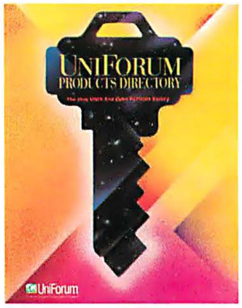
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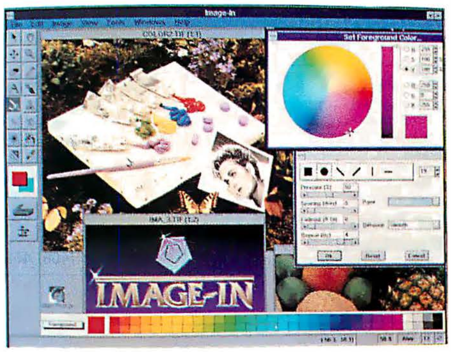


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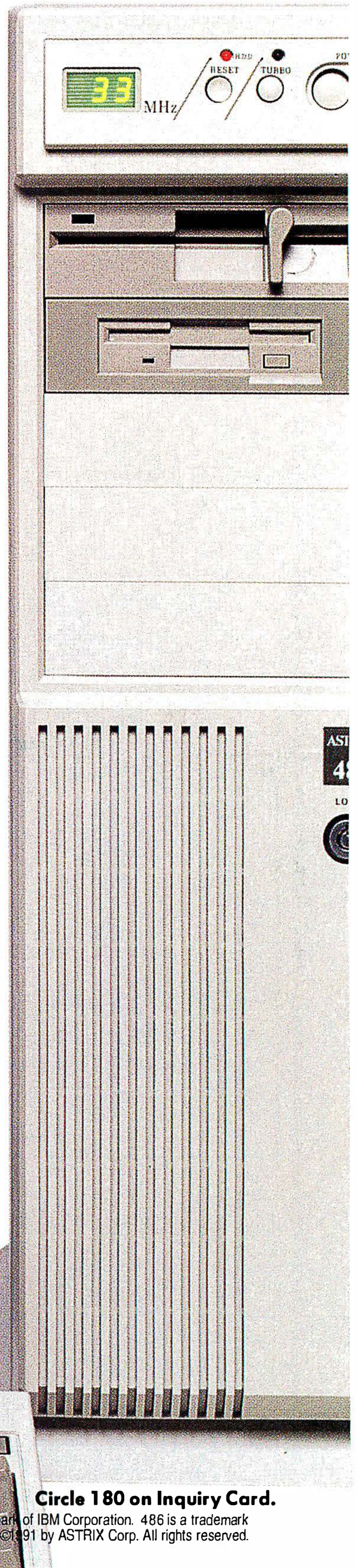
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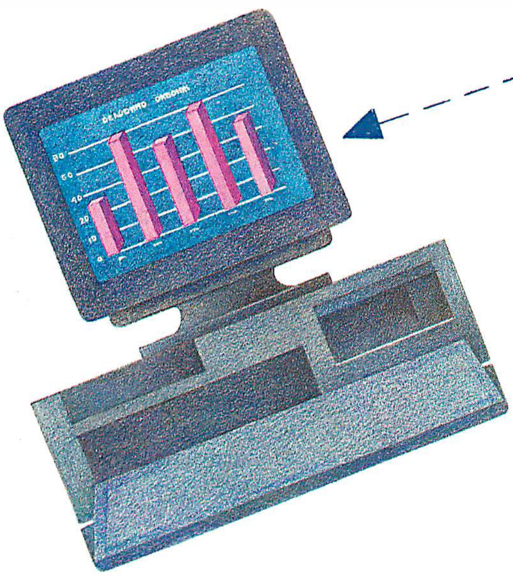
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HUGH KENNER

Mirror Worlds

The ultimate database might mirror reality

Every medium, thought Marshall McLuhan, is entangled with an earlier one. Most computers work at emulating typewriters, which in their time emulated printing presses. Spreadsheet packages maintain the typewriter model, though with a calculator grafted on. Change a percentage, recalculate, recopy: Nothing new except automation's speed.

But if David Gelernter is right, get set for More! Much More! His *Mirror Worlds* is subtitled "The Day Software Puts the Universe in a Shoebox . . . How It Will Happen, and What It Will Mean." Gelernter, whose fields of expertise at Yale are computer science and AI, reminds us that the millions of bits on a CD might be lamely described as "a list of instructions that tell the CD player what to do," although "encoded music" would be a better term. Likewise, think of any software package not as a list of instructions but as an encoded machine. So what kind of machine would you like? Forget typewriters. How about a Grand Central Station of information? A mirror world?

"These Mirror Worlds are like regular old-fashioned databases to some extent," but much more powerful. The version chiefly discussed is a mirror of your city, and it's a "high-tech voodoo doll," since "by interacting with the images you interact with reality." So, "you can parachute in your own software agents. They look out for your interests, or gather data that you need, or let you know when something significant seems to be going on."

How's the traffic just now? Let's see a picture. Zoom in on the Five Points area. Ugh. Better try a different route to the office. And Aunt Em's surgery? A few keyclicks: Good, she's out of intensive care. That saved a quarter-hour of fretting on hold. Her doctor, by the way, had a message yesterday nudging him to try Test W; that was thanks to an all-points alert from an expert: "If a patient ever shows up who is suspected to be suffering from X, and a W test isn't scheduled within 24 hours, let someone know." Yes, "constant vigilance to every possible source of screw-up." If, even once in a decade, a warning like that comes awake to prevent one serious medical glitch, we're delighted.

Aunt Em raises a principle. "The public at large is entitled to enter the City Hospital Mirror World, and to learn a good deal about what's going on. Furthermore, anyone is entitled to see his own medical records. But very few people have access to anyone else's, although they are all *stored* down here. Access to *private* information is closely controlled."

Not snoopware, then. "The goal is merely to convert the *theoretically* public into the *actually* public. What was always available in principle merely becomes available *in fact*." As to why this is important, Gelernter is a quick hand with analogies: The modern fighter aircraft, "so fantastically advanced you can't fly it," needs computer adjustment every few milliseconds lest it bop off out of control. And "modern organizations are close to the same level of attainment, except that, when they're out of control, they don't crash in flames; they shamble on blindly forever." Thus, local governments "hover close to the jagged edge of clique-ridden sham, engaging the interests of a negligible fraction of the voters." Suppose we could all learn what's really been going on? Especially the night before an election?

Yes, there's a fairly strong political subtext. But most of *Mirror Worlds* is devoted to persuading us that the Mirror World software is just about at hand. Briefly, it depends on recursion (do the same thing on progressively larger scales) and resembles the "objects" BYTE readers hear so much about: neat capsules that contain instructions and await specifics. Being aimed at that mythical being, the General Reader, the exposition is deft with metaphor. I'll skip past many very interesting pages to alight on the book's epilogue, where Ed and John are having a chat.

Ed uses a Mac but hates manuals and "boring complexity that imposes on my time." John says, "Lighten up, these things are *fun*." Two temperaments. And soon Ed is complaining about technology—"a centrifuge . . . designed to stratify society on a person's fondness for playing games with machines." John proposes that Wordsworth's sentiment—*To me, the meanest flower that blows can give / Thoughts that do often lie too deep for tears*—has degenerated to Greenpeace, with "a nasty, desperate edge today, because it's dying." As it may be, says Ed, but the future then seems to be, "Know everything, feel nothing." So, Mirror Worlds: "A perfectly clean, neat, analytical silence," a paving of the riverbed, a huge exclusion. No more smells, chirps, oinks, rustlings. Just Overview. Yes, Ed has a point. Imagine yourself hooked on Overview. Would you (now) like yourself (then)?

What's finally disarming about the book is Gelernter's acceptance of Ed and John as alter egos. Yes, he thinks Mirror Worlds is imminent. Yes, he's enthusiastic. Yes, he's ambivalent. He ends up "smiling wryly."

But a smile still more wry is conceivable: Science? Or science fiction? Is software of such complexity thinkable? Maintainable? Do we really want who-knows-who (Mafia, IRS) watching everything? Utopia, then, or galloping paranoia? Finally, the record of futurists hasn't been good. What they've tended to foresee, not being wanted, never came to pass. In the 1930s, TV was to supplement the telephone. See Aunt Em while you talk with her! But nobody cared. TV eclipsed radio instead. ■

Mirror Worlds, David Gelernter, Oxford University Press, 1991, $24.95 in softcover, 237 pp., ISBN 0-19-506812-2.

Hugh Kenner is Franklin and Callaway Professor of English at the University of Georgia. He writes for publications ranging from the New York Times *to* Art & Antiques. *His recent books include* Mazes *and* Historical Fictions. *You can contact him on BIX as "hkenner."*

Your questions and comments are welcome. Write to: Editor, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458.

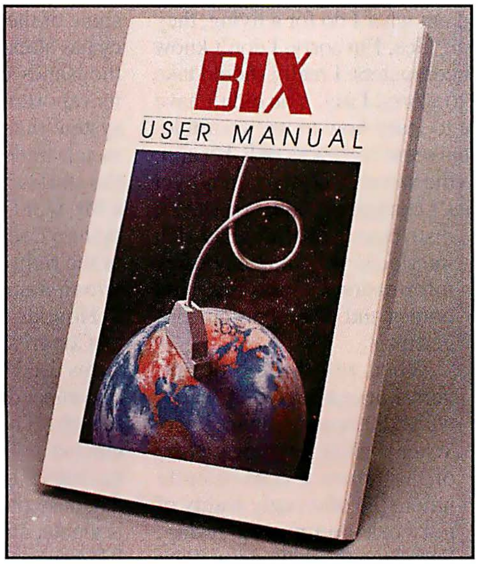
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STOP BIT

JON UDELL

INFOGLUT AT YOUR FINGERTIPS

When people find out what I do for a living, they often apologize: "Gee, I'm sorry, I don't know anything about computers. I really should take a course." Not to worry, I say. You didn't have to go to school to learn how to use your telephone, did you? Computers seem hard now only because they can't quite melt into the woodwork; they aren't yet simply appliances. But that's changing. Global networks, distributed software, and rich interfaces will someday carry information to our offices and homes and place it at our fingertips.

Even as more and better information search-and-retrieval systems become available, the major problem worsens: There is no common way to use them all.

When will this era of universal access arrive? Clearly, we've got some distance to go. When I paint my rosy picture of the future, I conveniently ignore the often ugly reality of network computing today. Spend too much time wrestling with memory managers, configuration files, routers, or interrupt request conflicts, and it's easy to lose sight of the big picture. Still, I take for granted that the nuts and bolts will eventually fall into place. I fully expect that we'll see gigabit-per-second data highways and distributed applications that exploit them by the turn of the century. What worries me is whether I'll be able to find what I'm looking for.

A friend who works at Lotus Development told me that he sold a used car in just 2 hours by posting an ad in a Notes database. The scary twist is that he spent the first 90 minutes just trying to figure out which Notes database to use. Here, I think, lies the ultimate challenge of "information at your fingertips." Who's going to put it there, and how?

Information scientists have thought long and hard about this problem. In general, there are just two approaches: Throw everything into the pot and index it all, or carve things up into chunks and index those. Even with storage, networks, and processors gaining size, speed, and intelligence at a breathtaking rate, it's hard for me to imagine that a planetary database will ever be effectively indexed in its entirety. Most theorists agree that there can be no substitute for the venerable 2000-year-old Aristotelian method: classification. How can we, entering the third millennium, apply that technique to a knowledge base undergoing explosive growth?

Eventually, of course, we'll have to get machines to do some of the classification for us. The Reuters news agency has already taken a step in this direction. Every day, the thousands of news stories transmitted to Reuters from its reporters around the world pass through an expert system that assigns category codes. If you're a precious metals trader, you'll want your Reuters feed to include all the stories about gold and to exclude those that mention a Mr. Gold or the American Express gold card. Reuters's system does in fact attain both high recall (it finds most of the right items) and high precision (it finds few of the wrong items). That's a laudable achievement.

How do the Reuters categories relate to the Library of Congress Subject Headings, or to the sets of index terms used by Nexis, ABI/Inform, and the countless other compendia you might consult during a no-holds-barred search? They don't. A bird's-eye view of the world's electronic databases reveals an archipelago, each island having its own passport and dialect. You can't fault the database publishers. No standard controlled vocabulary is viable, and none seems likely to emerge anytime soon. It's not even clear whether such a thing is possible. Certainly the task is so daunting we'd all prefer that legions of Connection Machines or Knowledge Navigators will render it moot. But while we're waiting around for the world's information systems to spontaneously organize themselves, can't we do anything to improve matters?

Think about what happens when a company forms and brings a product to market. It's up to the company to ensure that its own name and the name of its product don't infringe on established names. Why bother? Pure self-interest: It's expensive to retool your packaging and advertising when someone challenges a name you've neglected to trademark. Now imagine the same self-interest at work helping to categorize goods, services, and information products so they'll be found when searched for. Nobody would force you to classify your widget, your store, your book, or your TV program, nor would anyone care whether you'd used the correct terminology. But just think of the advertising dollars you'd save if you hit on the right combination. ■

Jon Udell is a BYTE senior technical editor at large. You can reach him on BIX as "judell."

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When he arrives, he will have been briefed on your problem. Given a history of your system. And equipped from a multi-million dollar parts inventory.

In short, a computer commando.

But the best part about Critical Care is that you'll probably never have to use it. Our award-winning technical hotlines solve 90% of problems reported over the phone, usually in 10 minutes or less.

So call us and ask for more details about Critical Care. Or call the other guys and ask about their emergency service. They'll get back to you.

Eventually.

800-553-6039

TO ORDER, CALL. PLEASE REFERENCE 11E61.
HOURS: 7AM-9PM CT MON-FRI, 9AM-4PM CT SAT, 10AM-3PM CT SUN
IN CANADA, CALL 800-668-3021. IN MEXICO, 95-800-010-0664.



△Same-day 4-hour on-site service available provided that Dell initiates service dispatch by 2pm CT. 4-hour service contract must be purchased. Critical Care is a service mark of Dell Computer Corporation.

SOME MORE LOW BLOWS TO THE COMPETITION.

Here's news that's going to make a lot of computer manufacturers wince. We've dramatically reduced the prices of our entire range of Dell systems. So now you can buy one of the best computers on the market without knocking out your budget.

And while other companies' standards often go down along with their prices, we'll still give you the

LOWERED BY $220



Dell 316SX 16 MHz i386SX System☆
System includes
50 MB Hard Drive, VGA Color Monitor, 2 MB RAM

- 1024 x 768 integrated video support
- Novell certified
- Expandable to 8 MB RAM
- 3 16-bit expansion slots
- Keyboard Password Protection
- 1 floppy drive

LOWERED BY $300



NX20 from Dell 20 MHz i386™SX System☆
System includes
40 MB Hard Drive, VGA LCD, 2 MB RAM

- 60 MB Hard Drive also available
- 8.3 x 11" footprint
- 6.8 lbs.
- 2-3 hour battery life
- CCFT edgelit triple supertwist display
- 32 Gray levels
- Full size keys with 3mm travel
- Modem, memory and coprocessor options
- One year return to factory warranty.

LOWERED BY $300



Dell 486P/20 20 MHz i486™SX System☆
System includes
80 MB Hard Drive, UltraScan™ 14C Color Monitor, 4 MB RAM

- Upgradeable processor design
- 40% faster performance than 386DX systems
- Keyboard Password Protection
- RAM expansion to 64 MB
- 1024 x 768 integrated video support
- 1 floppy drive

service and support package described by *PC Week's* editors as "overkill." Our toll-free technical hotlines solve 90% of reported problems over the phone, usually in 10 minutes or less. Our TechFax℠ line offers system information 24 hours a day. And if needed, a trained technician can be at your desk-side with a solution in hand, usually by the next business day.^

Perhaps this is why Dell comes so highly recommended. After all, we've won *PC Week's* Corporate Satisfaction Poll for PCs, portables and servers an unprecedented eight times.

So call us and find out why over two-thirds of the FORTUNE 500® now use Dell computers. But don't bother talking to our competitors; they're a little short of breath.

We just took the wind out of their sales.

DELL COMPUTER CORPORATION

800-553-6046

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LOWERED BY $800



Dell 486P/33 33 MHz i486 System*
System includes
100 MB Hard Drive, UltraScan 14C Color Monitor, 4 MB RAM

- Upgradeable processor design
- Programmable Flash EPROM for easy BIOS upgradeability
- Expands to 64 MB RAM using 32-bit SIMMs with gold-plated connectors
- 1024 x 768 non-interlaced monitor with 70 Hz refresh rate for flicker free operation
- 1 floppy drive

LOWERED BY $1,000



Dell 486D/33 33 MHz i486 System*
System includes
200 MB Hard Drive, UltraScan 14C Color Monitor, 4 MB RAM

- 5 storage bays, 6 16-bit slots
- 8 KB internal cache
- RAM expands to 64 MB using 32-bit SIMMs with gold-plated connectors
- 1024 x 768 non-interlaced monitor with 70 Hz refresh rate for flicker free operation
- 1 floppy drive

AND INTRODUCING



Dell 486D/16 16 MHz i486SX System*
System includes
50 MB Hard Drive, VGA Color Monitor, 2 MB RAM

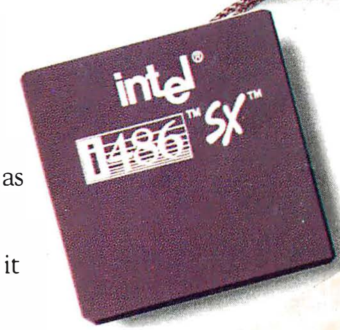
- Upgradeable processor design
- Programmable Flash EPROM for easy BIOS upgradeability
- RAM expands to 64 MB using 32-bit SIMMs with gold-plated connectors
- SmartVu™ Diagnostic Display
- Supports up to 5 storage devices
- 6 16-bit expansion slots
- 1 floppy drive

intel inside

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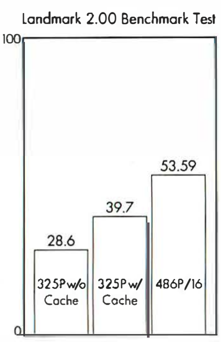
AFTER YOU PUT YOUR JAW BACK IN ITS PLACE, CALL US.



You'll find the Dell® 486P/16 as surprising as our competitors find it shocking.

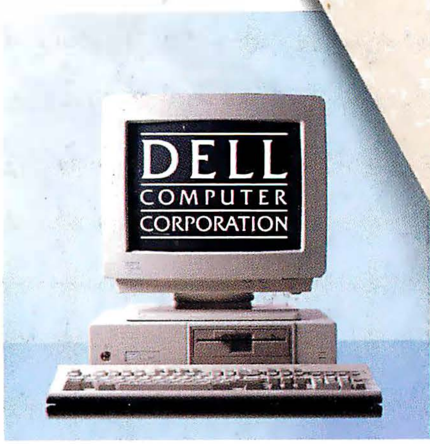
It delivers full-fledged i486™SX performance at the price of an i386™DX machine; up to 40% more processing power at virtually no additional cost.

And that's just for starters. Because the 16 MHz i486SX processor easily upgrades all the way up to a high-end 33 MHz i486DX system, and even beyond.



In other words, this is a computer that comes with the future built in. Along with some Dell technical innovations you'll be amazed to get at a price like this. Features like programmable Flash EPROMs, for example, that make BIOS upgrading a matter of slipping in a diskette. 32-bit SIMMs with gold-plated connectors for greater reliability. And built-in 1024 x 768 video support for high resolution graphics.

All this, starting at an unbelievable $1,749 for a complete system. So when you've finished staring at this page, call for more information about the Dell 486P/16. We'll be happy to talk to you. Even if you're speechless.



$1,749 Lease*: $66/Month**
Dell 486P/16 16 MHz i486SX System
System includes 50 MB Hard Drive, VGA Color Monitor, 2 MB RAM and 1 Floppy Drive

800-545-7133

TO ORDER, CALL. PLEASE REFERENCE 11EC2.
HOURS: 7AM-9PM CT MON-FRI, 9AM-4PM CT SAT, 10AM-3PM CT SUN
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